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The Rensselaer Polytechnic Institute and the Development of Engineering Education.*

When Stephen Van Rensselaer on Nov. 5, 1824, founded this institute and stated its purpose to be "the application of science to the common purposes of life," he laid a foundation broad enough and deep enough upon which to erect a university of technology. However, it was modestly called the "Rensselaer school," and the board of trustees publicly announced that the school was prepared to give "instruction in chemistry, experimental philosophy and natural history with their application to agriculture, domestic economy and the arts; and also for teaching and surveying."

There were two professors, Amos Eaton, professor of chemistry and natural philosophy and lecturer on geology, land surveying, etc., and Lewis C. Beck, professor of botany, mineralogy and zoology. There were twenty-five students. The degree of bachelor of arts was given after one year, and master of arts at the end of a second year of study. Much attention was given to field and laboratory work; in fact a circular issued in 1826 stated that the school was "limited to an experimental course in natural science," and it was confined principally to botany, geology and mineralogy.

After nine years, in 1833, the name was changed to "Rensselaer Institute." With this higher sounding name came an effort toward higher education, and in 1835 there was established "a department of mathematical arts, for the purpose of giving instruction in engineering and technology." At that time the degree of civil engineer—C. E.—was established and was given to eight graduates in the department of mathematical arts; eleven years after the founding of the school.

The course of study still covered only forty weeks of one year, and there were only three professors and one assistant. A circular issued in 1835 said: "One year is sufficient for obtaining the Rensselaer degree of civil engineer, for a candidate who is well prepared to enter. Graduates of colleges may succeed by close application during the twenty-four weeks in the summer term."

Of the forty weeks required by this course, the mornings of four weeks were devoted to "extemporaneous speaking on the subjects of logic, rhetoric, geology, geography and history," and the afternoons to composition, exercises in various mathematical arts, and national and municipal law.

What would the graduate to-day think of securing his degree after only forty weeks of work and giving 10% of that time to oratory, composition and the law?

Another Epoch.

After another period of eleven years, another epoch and a long step forward was made, when B. Franklin Greene became senior professor in 1846. After a careful study of the scientific and technical institutions in Europe Professor Greene thoroughly reorganized this institution upon the basis of a polytechnic institute, and it was then called the Rensselaer Polytechnic Institute. The managers resolved that "their field should be narrowed and more thoroughly cultivated," and their efforts "restricted to matters immediately cognate to architecture and engineering." The somewhat irregular and optional course requiring but a single year, was then superseded by a systematic and thorough curriculum requiring at least three years. The new curriculum considerably resembled the three years' course of l'Ecole Centrale des Arts et Manufactures, while the part forming the ground work of the higher technical studies resembled the curriculum of l'Ecole Polytechnique. By the year 1854 the courses in civil engineering and natural science had been well developed. In 1857 the course in topographical engineering was added, but it was abandoned in 1866, only five men having taken the degree of T. E. In 1858 the four-year course was established in civil engineering. In 1862 the course of mechanical engineering was added to those of civil and topographical engineering and natural science, and all four courses were extended to four years, the first two years being the same in all. The course in mechanical engineering did not, however, materialize, and students who wished to pursue their studies in mechanical engineering were obliged to go abroad, there being no established schools in this country at that time teaching that branch of engineering. The course in topographical engineering having died in 1866, a noble effort was made in that year to establish a course in mining engineering under the able direction of Professor Maynard, but it succumbed in 1871 to adverse conditions, after graduating twenty-three men. The same fate befell the course in natural science, so that in 1871 there remained only the course in civil engineering to represent the general polytechnic school which was the dream of Professor B. Franklin Greene. While the institute in 1871 ceased to be a polytechnic institute except in name, it was still an excellent school of civil engineering, and has grown in excellence and importance as a school of civil engineering from that day to this.

* * * * *

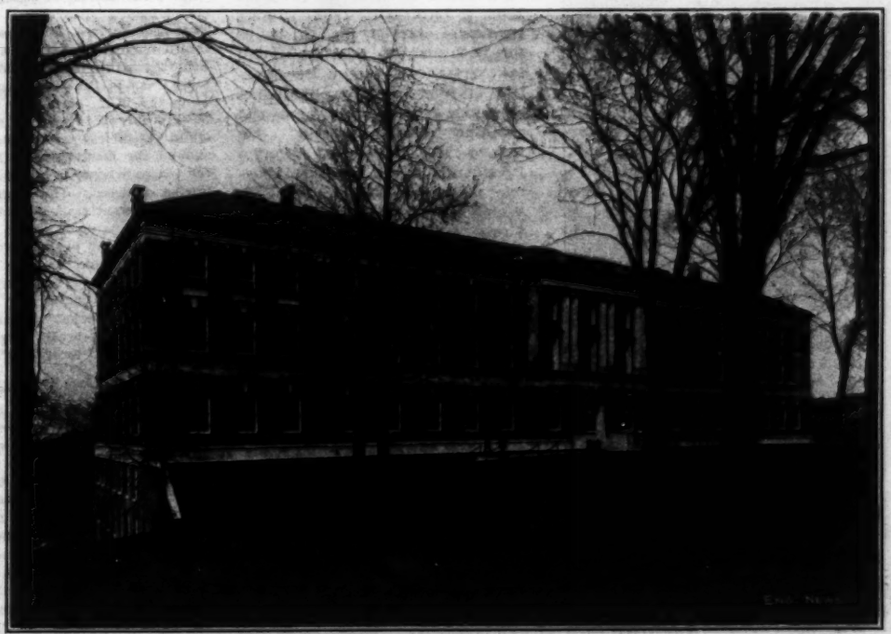
The establishment of the courses of mechanical and electrical engineering in addition to civil engineering at the institute simply means that the trustees and faculty have recognized the demand for a higher and broader education in engineering.

A student entering the institute selects that course which, at the time, seems most attractive to him, or which he has been persuaded to take by his parents or friends or the professors or because his chum is taking the same course. He goes through the course, wins his coveted degree of M. E. or C. E. or E. E. and is launched into the practice of engineering. Whether he receives the degree of M. E. or C. E. or E. E., he cannot know in advance that his practical work will be along the lines of that branch of engineering indicated by his degree. It often happens that a young man with an M. E. degree in his pocket is called upon to assist in making a railway survey, or a man with a C. E. degree finds himself trying to design a steam engine, or an E. E. graduate is ordered to report on a water power. These different courses of study leading to these various degrees should each be so complete in itself that a graduate from either course would not be surprised or feel himself incompetent when called upon to solve an engineering problem which might be classed in the specialty of another course.

After all, these various courses of instruction only constitute the school education of the young graduate in engineering; it is just the beginning of his education as an engineer. It teaches him how to think and reason accurately and correctly and informs him of possible sources of further knowledge.

Every graduate from the institute, whatever his degree, is entitled to, and should receive, the same fund of knowledge and information in order that he may start even with the others in the race for success in the profession of engineering.

About sixty years ago B. Franklin Greene reorganized the institute along the lines of a celebrated school of



FRONT OF THE NEW RUSSELL SAGE BUILDING FOR THE DEPARTMENTS OF MECHANICAL AND ELECTRICAL ENGINEERING AT RENSSELAER POLYTECHNIC INSTITUTE.

*Extracts from the address of Jesse M. Smith, President American Society of Mechanical Engineers, at the dedication of the Russell Sage Building for the Mechanical and Electrical Engineering Departments of Rensselaer Polytechnic Institute, Troy, N. Y., June 15, 1909.

engineering in France. Forty years ago that French school was conferring degrees corresponding to the four degrees in this country of mechanical, civil, metallurgical or chemical engineer. The instruction was identical in all four courses. The application of that instruction, by the preparation of a separate project of thesis every month of the last two years of study was along the lines of the specialty indicated by the degree. The diploma conferring the degree of engineer of arts and manufactures, at that time stated on its face the specialty in which the student had applied his instruction, but to-day the diplomas make no mention of the specialty, all are alike. Every graduate from that school has had the same opportunity to obtain his school education in engineering; all have begun their practice on the same basis, and all have applied their knowledge to such special work as came to them in their practice.

Is it not possible that in the future demand for a still broader and more fundamental school education in engineering, at this institute, will require that all graduates shall receive the same general degree in engineering and that after say ten years of practice, when each graduate has discovered what his specialty is and what he is best fitted for, he may return to the institute and be examined for a degree in his chosen specialty. I hold for the highest possible school education for the engineer without regard to specialty.

OLSEN COLUMN TESTING MACHINE OF 600 TONS CAPACITY INSTALLED IN THE MECHANICAL ENGINEERING BUILDING OF RENSSELAER POLYTECHNIC INSTITUTE.

THE MOUNT ROYAL PUMPING STATION, at Baltimore, Md., in which defective foundations threatened the safety of the building (Eng. News, March 12, 1908, p. 267) has just been put in a satisfactory structural condition as a result of nearly two years of repair work. As the contractors who put in the work are dead, the repairs were carried out under the direction of the city engineering department. It is thought that now the walls and foundation are perfectly safe.

A Second Master's Report in the Long-Delayed Peoria Electrolysis Lawsuit.

A dozen years ago a suit was brought by the Peoria Water-Works Co. to protect its water mains from electrolysis caused by currents from the local street railway system. The suit has dragged on or lain dormant ever since. Recently, there has been movement in the form of a second court reference to a master, who made a report a few weeks ago. For the benefit of the new generation of readers that has come up since the suit was begun we present a brief outline of its history:

The taking of evidence in the Peoria electrolysis suit was begun in 1898 before Special Master Frank L. Wean, who was appointed by Judge P. S. Grosscup, then of the U. S. District Court, to hear testimony and report his conclusions thereon. The taking of testimony occupied about a year, hearings being had in Peoria, Chicago, Milwaukee, Terre Haute, Cincinnati, Albany, New York, Brooklyn and Philadelphia. In all, 78 witnesses were examined, most of whom were experts, the number being about equally divided between the two sides. The master heard arguments early in 1900, and delivered his first report May 30, 1901. Judge Grosscup heard arguments on the defendant's objections to the master's report on June 30, 1902. Late in 1902, Judge Grosscup notified the attorneys for both parties that he would take more evidence on the question of remedy and would name his own experts, call them and examine them himself. He named Mr. Charles A. Coffin, President of the General Electric Co., and Messrs. Stone & Webster, of Boston. Messrs. Stone & Webster having declined to testify further in the case, on the ground of their business interests, nothing more was done along this line; and something over two years ago, no decision having been yet rendered in the case, it was, at Judge Grosscup's suggestion, transferred from him and is now in the hands of Judge Sanborne, of Wisconsin.

The defendant having asked leave to re-open the case, in order to submit new evidence on improvements in the state of the art of remedying the trouble, Judge Sanborne in October, 1907, appointed Special Master Wean to hear this new evidence, and hearings were had for that purpose in March, April and June, 1908. The master's second report brings the case down to date. Like the first one, it is entirely in favor of the water company.

Mr. Wean, after reciting dates and other routine matter, and stating that 985 pages of additional testimony had been taken, reported to the court on June 1, 1909, as follows:

In March, 1908, the defendant was operating about fifty single-track miles of railway lines in the city of Peoria and vicinity. The rails in use were largely of the girder type, 7 ins. high, 60 ft. long, and weighing 80 lbs. per lin. yd. On the streets in the business parts of Peoria, these rails were laid on hardwood ties, the latter embedded in concrete, and the space between the rails and between the tracks paved with a hard, vitrified brick, set on edge so as to bring the surface of such pavement even with the top of the rails, the portion of the street adjoining said tracks, being also paved with like material and in a similar manner.

Defendant's return system, at the same time, consisted of its rails, bonded at each rail joint with two No. 0 copper wires, in a manner commonly known as the "channel pin bond." At the time above specified, the defendant was engaged in the application to the rail joints of its system, of "the brazed bond," and in March, 1908, the latter had been applied to the rail joints on about three miles of track. This brazed bond, according to the evidence, is one of the most efficient devices for continuing the electrical conductivity of the rail return at the rail joints, but is no more efficient in that respect, than the welded joint, or certain other methods of bonding, which have been in use for a longer time. Where special work existed in the track construction, the rails and tracks were cross-bonded.

The defendant also had as a part of such return system, about six miles of negative overhead return wires, running from its power generating station to different parts of the system; these negative returns at the terminals being connected with rail and tracks, and at the power station with the negative busbar of the dynamos.

A considerable portion of this work had been done since the close of defendant's evidence on the former hearing, and is in the nature of an improvement to the conductivity of the return system in the way of heavier rails, double rail bonds, cross bonding, additional negative return feeders, and, so far as had been applied, the brazed bond; but, during the same period, the average load on defendant's system had been largely increased, probably doubled, and, owing to this increase, and the fact that the large interurban cars are being run over some of the tracks in Peoria, it is more difficult to prevent the escape of electric current to the water pipes of complainant. While the principal purpose of such improvement has been to prevent the escape of the current from defendant's system, the evidence shows that, notwithstanding the means so employed, the current flow upon complainant's system has gradually increased, a portion of the current has continued to escape and work damage and injury to the proximate underground metallic structures, especially to the complainant's water pipes.

Since the closing of proofs on the former hearing, the complainant's distributing mains, in many instances, have been injured, and in some, rendered useless, by the return current of the defendant company. In these distributing mains, since 1893, there have been discovered: joint leaks in the 30-in. mains, 119; in the 20-in. main, 4; in the 16-in. main, 43; in other mains, 47; 2 breaks have occurred in the 30-in. main and 9 in the 20-in. main. Electrical surveys made as late as March 25, 1908, showed the most current flowing on the pipes in about the places where the greatest number of joint leaks and breaks occurred. The pittings in the mains, caused by flow of current from defendant's system, have been constantly increasing in depth. On South Adams St., where the depth of the pitting, according to the evidence under the former reference, was ⅛-in., in March, 1908, instances were found where the depth of pitting was 55/100-in. in a main, the total thickness of which is ⅜-in. The evidence appears conclusive that these pittings, leaks and breaks have been largely caused by the electric current escaping from the defendant's railway system.

The defendant offered witnesses who testified in substance that "all danger of injury" to complainant's water mains and system, from electrical currents generated by defendant in the operation of its street railway, could be prevented by the use of the brazed bond on all rail joints, in addition to the present bonding, together with proper cross bonding and "jumpers," thoroughly connecting all rails with each other, in all special work, and proper maintenance of overhead negative return wires, as described in said testimony; some of these same witnesses, also, on cross-examination, testified in effect that the plan proposed would not, and could not, wholly prevent the escape of electric current from defendant's system to the water system of complainant, but that the portion of the current that would still leave the rails, would be so small and so distributed along complainant's system as to do no damage on leaving the pipes.

Complainant's witnesses testified, in effect, that the plan proposed, as aforesaid, would not prevent the escape of some current and could not prevent the injury, and that any amount of electric current flowing upon and off the water pipes will cause injury where it leaves the pipe, through moist soil, and that such injury is directly proportional to the amount of current flowing, during any given period, and this proportion is established by a large preponderance of all the evidence.

The evidence offered on this re-reference, and herewith reported, as aforesaid, fails to disclose any method which will completely or substantially prevent the injury complained of; and all the evidence fails to disclose the discovery, since the hearing under the previous order of reference, of any new principle, or fundamental law, regarding the nature and effect of electric currents, or of any new method of preventing the escape of such current different in principle from those known at the time of the former hearing. In other words, the evidence on this reference, taken as a whole, tends to confirm the findings and conclusions stated in this Special Master's former report, numbered XIV., XV. and XVI., which are as follows:

XIV. A difference in potential of the fraction of a volt may cause electrolysis and from the conditions hereinabove found and stated, the ultimate destruction of complainant's pipes by the currents of electricity allowed to escape from defendant's system, is a question only of time and pressure.

XV. The evidence discloses no known method by which the complainant, by its own action, can protect its water distributing system of pipes and mains from the electric currents of the defendant's single trolley railways.

XVI. The evidence discloses no complete remedy for the injury to these water pipes, except the entire removal of electric current from the water mains; such removal is impossible as long as the return currents of the electric railways are grounded or in electrical contact with the earth. The other methods which have been suggested by the defendants in this case, do not, in practice, and cannot, prevent the escape of a portion of the current into the ground and water pipes.

The master finds and concludes that all the evidence offered on the present reference, fails to disclose any sufficient ground for changing or reversing the aforesaid conclusions.

According to Mr. Wean's first report (May 30, 1901), the evidence which he had taken showed that it was only a question of time before some of the water mains of the company would be absolutely destroyed by the return currents from the street railway system. The way was open for the street railway company to take and keep its currents off the water mains [the only question being one of expense.—Ed.]. Failure to do this would result in taking property for public purposes without due process of law, a violation of both the state and federal constitutions. The water company was, therefore, entitled to relief from the courts in the form of (1) damages for injuries already done; (2) restraint to prevent further injury. Editorial comment on this remarkable case—remarkable because of the court delays in the face of the emphatic findings of its master's report—may be found elsewhere in this issue.

An English Double-Deck Swing Bridge for Railway and Roadway Traffic.

In connection with the improvement of harbor and railway facilities at the docks at Bristol, England, the city Docks Department and the Great Western Ry. have built across the river Avon a double-deck swing bridge carrying a double-track railway on the lower deck and a roadway (with sidewalks) on the upper deck. It is said to be the largest and heaviest double-deck swing bridge ever built. The bridge spans an artificial or diversion channel known as the "New Cut," the natural channel of the river being incorporated in the harbor and dock system, and forming a "floating harbor" of considerable length which ends in a large dock connected at its lower end with the river by means of locks. The river traffic in the "New Cut" (and passing the bridge) consists mainly of barges and the smaller class of coasting vessels, the larger vessels entering the dock system at a lock below the bridge. The depth of water at low tide is about 3 ft., but the daily rise of the tide is from 20 to 30 ft.

The bridge forms a link in a connection between a railway line on the south side of the river, and the harbor railway and a new freight terminal on the north side. The freight terminal and its railway connections were described in our issue of Dec. 10, 1908. With this new railway connection, trains can be run between the docks and the main line of the Great Western Ry. without passing through the city freight terminals, thus avoiding a point where the traffic is very congested. After negotiations between the city and the railway it was decided to provide roadway facilities on the river bridge, as there is no other crossing for some distance on either side. The double-deck arrangement was adopted in order to avoid grade crossings. On each side of the river, roads branch off in both directions at the end of the bridge.

The general arrangement is shown in Fig. 1. The swing span is the main span of the bridge, and is approached on the south side by an embankment with a short plate-girder span carrying the roadway over the main line of railway. On the north side there is a double-deck truss span of 75 ft. 9 ins., beyond which are plate-girder spans for the roadway. The railway curves away from the roadway approach at the end of the bridge. The swing span is 202 ft. 6 ins. long, with unequal arms of 121 ft. 6 ins. and 81 ft. Its total weight (including the turntable, roller path, etc.) is 1,045 gross tons, of which the swinging part of the bridge represents 990 tons. The bridge is operated by hydraulic power.

The piers are of concrete, faced with stone masonry laid in cement mortar. The center pier is at one side of the river, leaving a navigable channel of 85 ft. width in the clear. Its concrete foundation is about 37 × 43 ft. The upper part is pierced by an arched opening having a brick arch roof. This opening reduces the obstruction to the flow of water and effects a saving in concrete, while the pier is of ample strength to carry its loads.

The bridge was designed and built under the direction of the late J. M. McCurrich, M. Inst. C. E., and Mr. W. W. Squire, M. Inst. C. E., who succeeded him as Chief Engineer of the Bristol Docks Department. To Mr. Squire we are indebted for plans of this interesting structure. Much of the information given below is from a paper read before the Institution of Civil Engineers (London) by Mr. Wm. H. S. Savile, Assoc. M. Inst. C. E., who was the Resident Engineer on the work. The superstructure was built by the John Lysaght Co., of Bristol; the hydraulic machinery by Sir Wm. Armstrong, Whitworth & Co., of Manchester; and the signal and interlocking plant by Saxby & Farmer, of London.

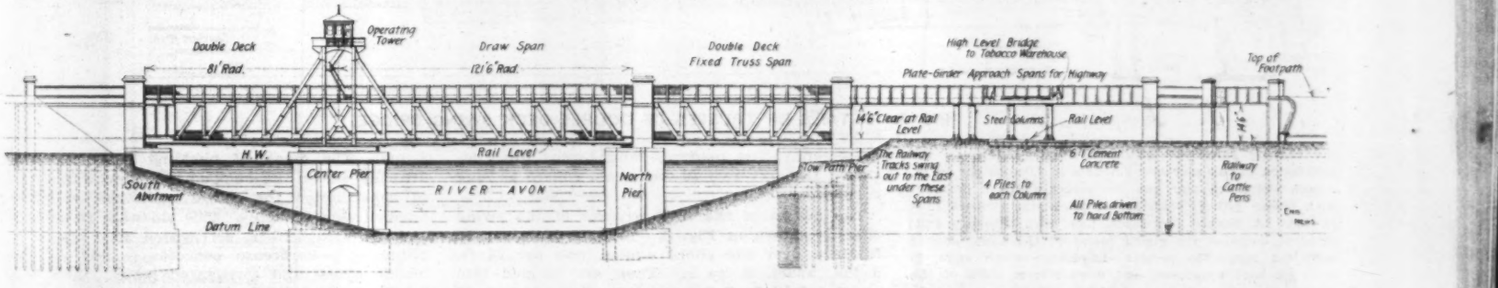


FIG. 1. ELEVATION OF DOUBLE-DECK DOUBLE-TRACK SWING BRIDGE WITH UNEQUAL ARMS, CROSSING THE RIVER AVON AT BRISTOL, ENGLAND; GREAT WESTERN RY.

Foundations.

The pivot pier and the north pier were built within cofferdams, the foundations being carried down to a stratum of red marl which was found at depths of from 8 ft. to 14 ft. below datum (or 10 ft. to 16 ft. below the bed of the river). The difficulties were increased by the great range of tide, the water rising and falling 20 to 30 ft. twice a day.

The north pier is built on a concrete foundation 19 × 58½ ft. about 13 ft. 6 ins. deep. This was built within a rectangular cofferdam 25 × 64½ ft. inside dimensions, leaving a 3-ft. space between the sheeting and the concrete. The location with reference to the navigable channel did not permit of the use of a double wall cofferdam.

Each side of the cofferdam consisted of a single row of piles 12 ins. thick, driven as close as possible and calked with oakum. Guide piles with diamond pointed shoes were first driven (about 11 ft. c. to c.) by a floating pile driver. Inside and outside walling timbers were bolted to these near the top and as low as the mud of the river bottom would permit. Intermediate piles (with shoes) were then driven, starting from each guide pile, until they left spaces small enough for closing piles. The sheet piles were then forced together as tightly as possible by screw jacks and wedges inserted in the open spaces, and the closing piles were specially dressed to fit the widths of these spaces. The closing piles usually made a tight joint, but in some cases they required careful calking.

The points of the piles were driven to about 13 ft. below datum, or about 2 ft. below the bottom of the foundation. Additional wallings and inside struts were then placed, and bags of clay were laid about 2 ft. deep on the outside, in order to protect the mud from scour. The top of the cofferdam was about 36 ft. above datum, so as to keep out all ordinary spring tides. At the mud level two sluice gates were provided. These could be worked from the top of the dam by means of a screw handle working on a long rod attached to the door, so as to allow of water being let in and out as required.

The excavation inside the dam was executed in three lengths, the middle portion being completed and the concrete laid to a depth of 6 ft., before the end sections were started. The first few feet of excavation was through river mud, which was followed by silt and stones overlying a bed of gravel about 6 ft. thick. Below this was a thin bed of marly clay, and next the red marl on which the foundation was laid, about 10 ft. 6 ins. below datum. Although the foundation was carried about 3 ft. deeper than had been anticipated, it was safely put in with a very moderate amount of pumping, the only pumps used being a No. 5 and a No. 6 pulsometer. A slight blow occurred during a flood when the masonry was about 2 ft. high, but it was easily stopped with bags of clay when the flood subsided. When the pier had reached a level about 6 ft. above the sills of the sluices, pumping became unnecessary, as the slight leakage on each tide did not fill the reservoir thus formed, and the water which did get in could be let out through the sluices at low water.

When the masonry had reached the level of ordinary spring tides the dam was removed by drawing all the piles, except a few which were cut off just above the concrete foundation. Under the maximum distribution of load on the bridge the pressure on the foundation amounts to 2.9 tons per sq. ft.

The concrete used throughout is 1:7 Portland cement concrete with a moderate number of displacers. The aggregate was broken stone and sand. The masonry facework is rock-faced random-coursed rubble, the stones being square on all beds and joints. The stone used for facework is entirely hard mountain limestone. The caps to the pilasters are of hard red sandstone.

The center pier was built inside a cofferdam of similar construction to that used at the north pier. The concrete foundation was intended to measure 43 × 37 ft., and the internal dimensions of the cofferdam at the top were 3 ft. more in each direction. The piles, however, ran inwards somewhat in driving, and the concrete foundation was actually laid solid to the piles. The piles (as at the north pier) were driven to about 2 ft. below the level at which the foundation was finally laid. In order to keep the dam watertight, bags of clay were packed against the sides to a height of 4 ft. or 5 ft. above the mud. These were kept in position by a row of steel rails driven upright into the river bed about 30 ins. apart, and about 3 ft. from the outer face of the dam.

The excavation proceeded satisfactorily, and two No. 6 pulsometer pumps were sufficient to keep the site dry until a level of 4 ft. below datum was reached, when a blow occurred at the southwest corner. This blow was stopped by working at low tide, a trench being made on the outside of the dam and filled with clay after the piles had been calked. This enabled the dam to be pumped out again, and the excavation was proceeded with. When, however, it had been carried 2 ft. deeper, another blow occurred. Although many attempts were made to stop the blows, it was not found possible again to make the dam watertight at high water. The remainder of the excavation was therefore done at low water, when the head was not sufficient to reopen the

blows. The sluices were kept permanently open during this period of the work, and an 8-in. centrifugal pump was used, in addition to the two pulsometers, in order to pump out the dam as quickly as possible when the tide fell below the level of the sluices.

The head of water above the bottom of the foundation was 18 ft., even at low tide; and at high tide it was as much as 45 ft. It will readily be understood, therefore, that the construction of a watertight dam presented considerable difficulties, especially as it was not possible to make a double-wall cofferdam, as the extra width would have reduced the channel of the river too much.

The excavation was carried out in two sections, and about 12 ft. of concrete was laid in the down-stream half before the excavation was completed in the up-stream half. On the completion of the concrete foundation, which is 16 ft. thick, the tide was again excluded from the dam and the masonry work was all built in the dry.

The facework of the pier, as in the case of the north pier, is of random-coursed rubble masonry, and the backing is of 1:7 concrete with displacers. The bed-stones on the upper surface, which take the roller-path and center-pivot castings, are of granite, fine-axed on the bearing surfaces. The maximum pressure on the foundation of this pier also amounts to 2.9 tons per sq. ft.

Both the north pier and the center pier are provided with fender piling consisting of pitch-pine timbers 12 × 12 ins. A timber protection pier with strongly constructed dolphins (or guard piers) at the ends, and of sufficient length to protect the bridge when open, is built on both up-stream and down-stream sides of the center pier.

The river end of the south abutment, on which the rear end of the swing-span bears, is founded on concrete taken down to the marl at a depth of 15 ft. below datum, and laid inside a single-pile cofferdam to exclude the high tides. Very little water was encountered until the bed of gravel overlying the marl was reached, after which pumping had to be carried on continuously. The remainder of this abutment consists of two walls, one on each side of the railway and running parallel with it. Transverse girders, 2 ft. deep at the center, span between these walls, and carry the roadway over the railway until the former bends away towards the east and is carried on an embankment. These walls are of rubble masonry with facework similar to that of the piers, but built in lime mortar. They are founded on pitch-pine piles, 12 × 12 ins., about 45 ft. long, which are driven to the marl.

In designing this and all the other pile foundations the maximum load allowed on a pile was 25 tons. The piles were driven with a 1-ton ram falling 10 ft., until the total set for the last five blows did not exceed 1 in.

Mr. T. B. Cooper, Assoc. M. Inst. C. E., engineer of the foundation work, has stated that the blows were caused by the presence of large stones in the gravel bed underlying the river mud. They also caused some uneven driving of the sheet piles for the cofferdam. In another case, with such a high rise of tide, he would prefer to build the pier of concrete monoliths.

Superstructure.

All steel work is of Siemens-Martin acid mild steel, having a tensile breaking stress of from 27 tons to 32 tons (gross) per sq. in., and a minimum elongation of 20% in 8 ins. The working stresses were 5½ and 6 tons per sq. in. net (in tension and compression) for the main trusses of the swing span and fixed span respectively; 5 tons per sq. in. net in tension and 4½ tons per sq. in. gross in compression for all floor beams (railway and roadway). The rivets are mainly ⅞-in., but ⅝-in. and ¾-in. rivets were used at some parts having thin plates. The rolling load assumed for the railway was a string of freight locomotives equal to 1.66 tons per lin. ft. for each track, with a maximum axle load of 18 tons. The railway floor beams and stringers were designed for the heaviest axle loads in use. The live load on the roadway was taken at 168 lbs. per sq. ft., this high figure being assumed in order to allow for future development. The roadway floor beams were designed to carry two 20-ton steam rollers passing each other.

The design of the main trusses of the swing span is shown in Fig. 2. These trusses are 19 ft. deep over the chord angles, and are 27 ft. 9 ins. apart, c. to c. They are divided into panels of 12 ft. 3 ins., with a single system of triangulation. The ratio of length to depth is 10.5 to 1. The trusses are built with an upward camber from the turntable, to insure against the ends dropping below the horizontal when swinging. The total rise is 2 ins. at the end of the longer arm and 1½ ins. at the end of the shorter arm. The sections of the members are shown on the drawing, and it will be noted that the gusset plates have curved sides. The chords are of trough section, with web plates ½ × 20 ins.; flange angles, 5 × 3½ × ⅝ ins.; cover plates 30 ins. wide, with an aggregate thickness of 3½ ins. at the middle.

The excess weight of the longer arm is balanced by 156 tons of counterweight at the end of the shorter arm. This is placed beneath the floor of each deck and in chambers formed by double web plates at the ends of the trusses. It consists of cast-iron slabs laid transversely between the flanges of heavy longitudinal girders in the end panel of each deck, the space between the slabs and decks being filled with concrete in which scrap iron is mixed.

The floor beams of the lower deck (for the railway) are 24-in. plate girders, reduced to 15 ins. in depth at the ends, where they rest on the flange angles of the bottom chords of the trusses. This is shown in Fig. 3. They are connected to the posts of the trusses by brackets, the gusset plates of which pass through the top flanges of the floor beams and are riveted to the web plates of the latter. This detail is shown at the left in Fig. 2. The track stringers are 15-in. plate girders 12 ft. 3 ins. long, having their tops flush with the tops of the floor beams. The framing of the floor beams and stringers is covered with a deck of 5/16-in. plates 3 ft. wide; the plates are laid transversely and connected by tee-bars which act as butt straps and stiffeners. The track consists of 87-lb. rails of bridge section, laid on longitudinal timbers of Australian jarrah, 5 × 14 ins.

The floor beams for the upper deck (roadway) are 24-in. plate girders, carried by brackets riveted to the truss posts as shown in Fig. 3. Between these are 12-in. stringers, with transverse 7-in. bulb tees forming a framing which carries 5/16-in. buckle plates, 5 ft. 9 ins. × 3 ft.

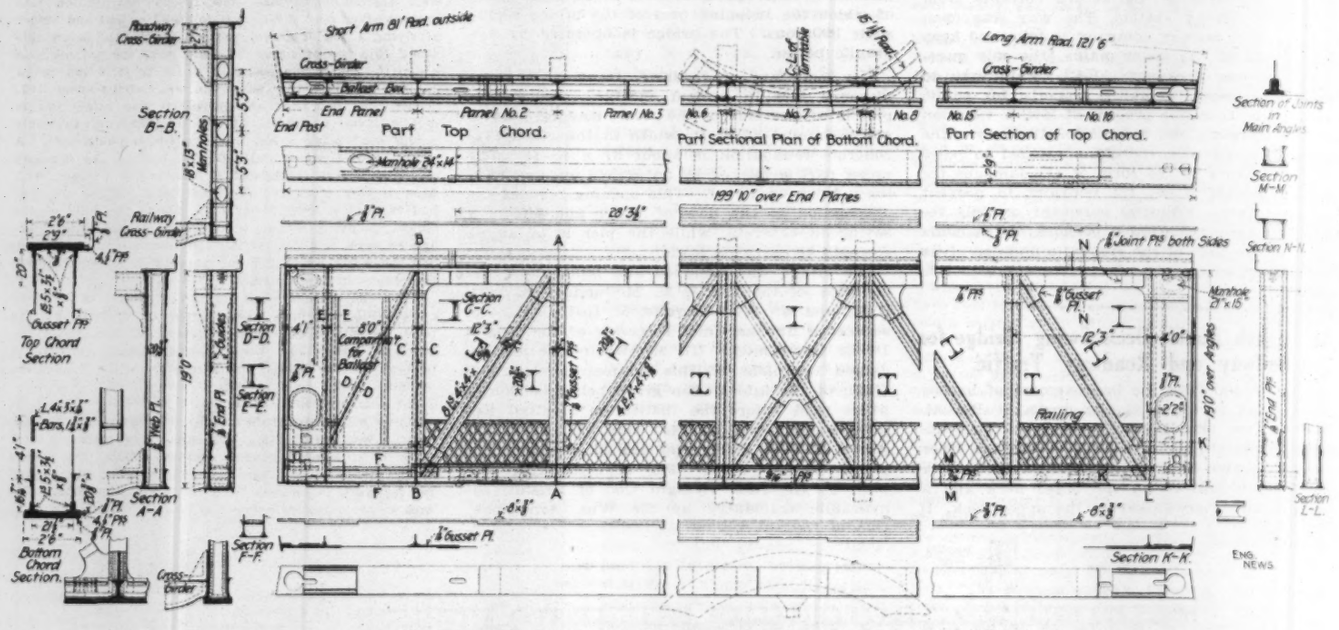


FIG. 2. DETAILS OF TRUSSES OF DOUBLE-DECK SWING BRIDGE.

The turntable (Fig. 3) has an annular box girder 30 ins. deep and 36 ins. wide; it has chord angles 6 × 4 ins. and diaphragms spaced 33 ins. apart. It is secured to the bottom chord of each truss by 36 turned bolts 1 in. diameter; it is bolted also to the floor beams and stringers.

Turntable.

which are made extra strong at this part of the bridge. Radial arms of plate-girder construction connect the girder with an octagonal cast-iron collar moving freely on the center pivot. This pivot is of cast iron, 2 ins. thick, anchored to the masonry by eight 1¾-in. lewis bolts. It has an upper bearing 24 ins. diameter for the turntable collar, and a 34-in. lower bearing for the collar of the roller frame. As the turntable is below the level of the highest flood tides, the top of the center pier is covered by a watertight casing of ⅜-in. plates carried on brackets fixed to the masonry. The bottom of this is made watertight by a 4-in. layer of fine concrete. Valves in the bottom of the casing allow of draining off any rain water that may collect.

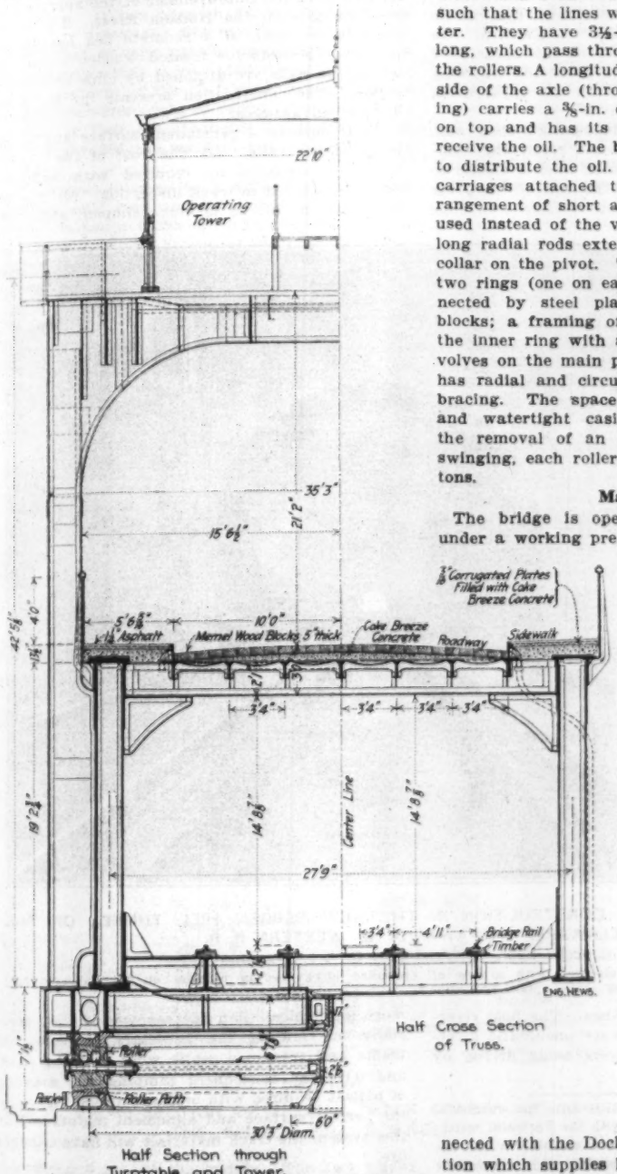


FIG. 3. CROSS-SECTIONS OF DOUBLE-DECK SWING BRIDGE.

The lower roller path, Fig. 4, is of cast steel. It is made in 12 sections with joints at 15° from the radial lines in order to avoid uneven wear. The upper and lower surfaces and the ends are machined. The sections are bolted together and to 2-in. steel base plates at the joints. The granite bed had recesses cut to receive these plates, which were then grouted in place, uniting the roller path solidly with the pier. The roller path is anchored by 24 cotter bolts and 24 lewis bolts, all 1½ ins. diameter. The pressure on the stone of the bed does not exceed 4½ tons per sq. ft. under any condition of loading. A cast-steel rack for the two operating pinions is bolted to the outside of the roller path. This is 10 ins. deep, with a pitch of 6 ins. and a diameter of 34 ft. 5 ins. on the pitch circle. The upper roller path is of similar construction, and is bolted to the turntable girder.

There are 34 rollers 30 ins. diameter at the center and 2 ft. wide on the face; the taper is such that the lines would meet at the pivot center. They have 3½-in. steel axles 4 ft. 8 ins. long, which pass through gun-metal bushings in the rollers. A longitudinal groove along the upper side of the axle (through the length of the bearing) carries a ⅜-in. oil pipe which is perforated on top and has its outer end bent upward to receive the oil. The bushings have spiral grooves to distribute the oil. The rollers have cast-iron carriages attached to a roller frame, this arrangement of short axles and roller frame being used instead of the very general arrangement of long radial rods extending from the rollers to a collar on the pivot. The roller frame consists of two rings (one on each side of the rollers) connected by steel plates and cast-iron spacing blocks; a framing of angles and bars connects the inner ring with a cast-iron collar which revolves on the main pivot casting. This framing has radial and circular members with diagonal bracing. The space between the roller frame and watertight casing is sufficient to permit the removal of an axle. When the bridge is swinging, each roller carries a load of about 20 tons.

Machinery.

The bridge is operated by hydraulic power, under a working pressure of 750 lbs., being connected with the Docks Department pumping station which supplies hydraulic power for the machinery operating lock gates, bridges over the locks, etc. The connection is made by two 2½-in. copper pipes laid 6 ft. below the river bed in order to allow for a future 4-ft. deepening of the channel. Vessels are not allowed to anchor within ¼-mile of the bridge, but as a protection against vessels dragging their anchors two heavy chains are laid across the bed of the river, one on each side of the pipe lines.

In the operating tower there are two three-throw reversible hydraulic swinging engines (one in reserve), with plungers 4 × 14 ins. These drive (by spur gearing) two horizontal shafts having bevel-gear drive to two vertical shafts at diagonally opposite corners of the tower. The lower end of each shaft carries an operating pinion of 23 ins. diameter on the pitch circle. The bridge is opened in about 1 min. 45 sec., and closed in about 2 min. 5 sec. It is always swung up-stream in opening. The bridge averages 270 swings per month, with an average interruption to traffic of 6½ mins.

When the bridge is swung to the closed position, the ends are raised slightly by four 16-in. hydraulic jacks; these are attached beneath the ends of the trusses and act against cast-iron bearing blocks on the bridge seats. When the ends are raised, sliding wedges or shoes are put in position on the bearing blocks and the jacks are released, allowing the bridge to take a bearing on the shoes. These shoes are operated by chains attached to hydraulic cylinders. The jacks are 16 ins. diameter, with a stroke of 3½ ins., but the actual working stroke is only ⅞-in. and ⅝-in. at the ends of the long and short arms of the bridge. Of this amount, ¼-in. is to clear the sliding shoes, so that the permanent movement at the two ends is only ⅝-in. and ⅜-in., respectively. For one complete movement of opening and closing the bridge, the amount of water used for the engines, jacks and shoes is about 182 British gallons. The cost of this is about 8.74 cts., based on the charge of 48 cts. per 1,000 galls. which is made by the Docks Department for power supplied to outside consumers.

At each end of the bridge is a locking bolt 3 × 4 ins., with a stroke of 5 ins. The lock at the end of the short arm is not used, however, as it caused trouble at one time by the bridge jamming when locked at both ends, so that the lock could not be withdrawn. This was due to the slight warping or horizontal curving of the structure on a sunny morning following a frosty night, the sun shining full on one truss while the other was in the shade and still cold. The bolt is held normally at the locked position by a spring, but is withdrawn by chains operated from a treadle lever in the tower when the bridge is to be opened. As the bridge closes, an inclined rubbing plate on the face of the abutment forces the bolt back until it reaches the socket of the cast-steel lock.

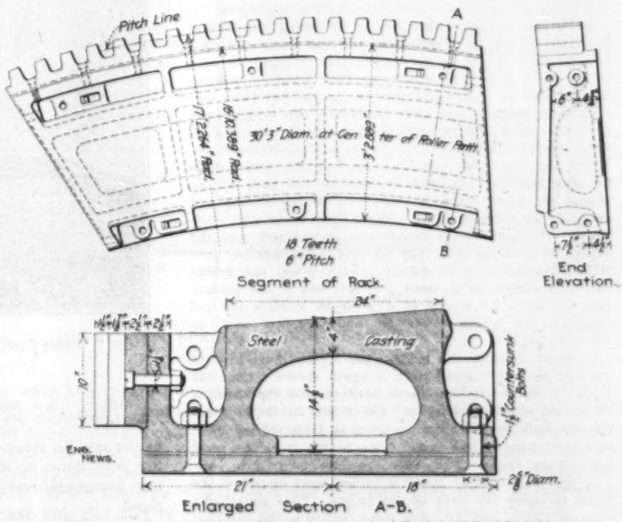


FIG. 4. RACK AND ROLLER PATH OF SWING BRIDGE.

Railway and River Signals.

One of the interesting features of the bridge is its equipment of signal and interlocking plant for the protection of the railway and river traffic. This is described in Mr. Savile's paper as follows:

NAVIGATION LIGHTS.—The lights provided for controlling the passage of ships at night are arranged with a view to always swinging the bridge so that the longer end will point up-stream when open. The reverse direction is intended to be used only to prevent accident in the event of a ship getting out of control when going down-stream and approaching too near to the bridge to allow it to be swung up-stream. The lights provided are as follows:

(1) A red light showing all round, fixed on the center of the swing-span immediately above the machinery tower. This light is provided with screens so that it can be obscured through arcs of 180° on either the up-stream or the down-stream side when the bridge is open.

(2) Two green lights fixed one at each end of the down-stream truss of the swing-span, above the level of the handrail to the roadway. Each of these lights is permanently masked through an arc of 90°.

(3) Two green lights, one on each of the pilasters of the north pier. These lights are each masked through

an arc of 90° on the north side, so that they are visible from the river, but not from the north approach road.

When the bridge is open for ships to pass, the red light at the center can be obscured on either the up-stream or the down-stream side, and this is the signal for ships to approach from that side. The illuminant for these lights is oil.

During the day, the signaling is carried out by means of two cones hoisted on the flagstaff on the machinery house; one of these is a north cone (point upwards) and the other a south cone (point downwards). When the bridge is closed for navigation, both cones are hoisted. When the bridge is opened, the north cone is lowered as a signal that vessels may pass down-stream, or the south cone is lowered as a signal that vessels may pass up-stream. The two cones are never lowered simultaneously, as vessels are not allowed to pass each other at the bridge. The yard on which the cones are hoisted is fixed so that it points across the river when the bridge is open, and parallel with the stream when the bridge is closed. This ensures both cones being visible from the river when the bridge is open.

The bridge-master has telephone communication with two stations each about ¼-mile distant, one above and the other below the bridge. From these stations he receives warnings at night or in foggy weather of the approach of vessels.

INTERLOCKING AND INDICATING.—The levers for working the machinery are interlocked with the railway signals so that the bridge cannot be opened until the signals are set against the trains, and the derails are open on each side of the bridge. This is effected by means of two pairs of interlocking bolts, one pair being situated at each end of the bridge on the railway deck level. One bolt of each pair is on the bridge, and is worked from the machinery tower; the other is on the abutment and is worked from the railway signal tower. Assuming the bridge to be set for railway traffic, both bolts are shot, and the bridge bolt cannot be withdrawn until the railway bolt has been withdrawn. Conversely, when the bridge bolt has been withdrawn, the railway bolt cannot be shot again, as a baffle-plate is moved in front of it and remains there until the bridge bolt is again shot.

When the bridge-tender wishes to swing the bridge for river traffic, he rings (from the machinery tower) a bell in each of the railway signal towers, and as soon as the signalmen have withdrawn their bolts he receives a reply signal. The withdrawal of the railway bolts mechanically releases the lever by which the bridge bolts are actuated, and he withdraws these bolts. This movement back-locks the railway bolts and electrically releases the lever for operating the end-lift jacks. This he then pushes over, and as soon as the ends of the bridge are lifted correctly, the lever of the sliding end shoes is electrically fixed. When the shoes are withdrawn, the ends of the bridge can be lowered, and the action of lowering frees the starting valve handle, enabling the bridge to be swung open. When the bridge has been turned to its open position, one of the screens can be raised by means of a lever to obscure the red light on the bridge tower for one direction only, as above noted.

In order to close the bridge, the screen must first be lowered so that the red light is again shown. Then the bridge is turned to the closed position, and the shooting of the automatic locking-bolt electrically frees the lever for the end-lift jacks. This lever is then pushed over, and the lifting of the ends of the bridge frees the lever for the end shoes. The shoes are then moved into position and the end-lift lever is pulled over to allow the jacks to lower the ends of the bridge. This electrically releases the interlocking-bolt lever, which is then shifted, thus electrically locking the swinging, end-shoe and end-lift levers, and mechanically releasing the railway bolts. These being shot, put an electric lock on the interlocking lever.

Electric indicators fixed in the machinery tower give the following information to the bridge tender: (1) Railway bolt, shot or withdrawn; (2) end-lift jacks, up or down; (3) end shoes, in or out; (4) automatic locking bolt, shot or withdrawn; (5) bridge set for road or river. Of the first four indicators, there are two sets, one for the nose end and the other for the rear end.

There is also an indicator to show the operator the position of the bridge during its entire movement, instead of only at the end of its swing. This is a safeguard in foggy weather, when the operator cannot see the end of the bridge and might cause it to foul the channel by failing to stop it when the indicator suddenly showed that the bridge had reached its open position.

Erection.

The swing span was erected in its open position upon the timbering of the permanent protection pier. This was reinforced by additional piling, well braced and covered with a timber deck. The maximum load per pile was limited to 15 tons. The steel work was delivered partly by rail and partly by barges. The turntable was first erected and adjusted, with its rollers, etc., complete. The bottom chords of the trusses were set on the annular girder, with the floor beams and stringers. On this panel of floor framing was laid a track for a traveling crane. This crane erected the truss members and lower floor system, the top chord sections being placed as fast as the posts were set up. The work was carried on in both directions from the center. For erecting the upper floor beams and for riveting work a traveling stage was built; this ran on rails on the lower deck and its platform was about 3 ft. below the bottom of the upper floor beams. When these were in place the traveling crane was lifted to a track on the upper deck, and used to erect the tower.

The compression plant, blacksmith's shop, etc., were on the south side of the river, the compressed air pipes being carried over a trestle to the center pier and under the bed of the river to the north pier. The shop riveting was done by hydraulic riveting machines. The field riveting was done mainly by Boyer pneumatic riveting hammers, very few rivets being driven by hand.

THE FORLANINI WATER-GLIDER.—The successful experiments on Lake Maggiore with the Forlanini water-glider have been conducted with a machine in the nature of a boat, shaped as a spindle, with a parabolic profile section pointed in front, so as to reduce the resistance to a minimum. Its extreme length is 9 m., the height is 66 cm., and the width at the widest part is 1.20 m. It is fitted with a 25-HP. White motor which drives a screw-propeller, beneath the surface of the water, at the rate of 3,000 r. p. m.

The total weight of the vessel is one ton. The lifting apparatus consists of three groups of blades or wings arranged one on each side at the stern and at the prow. The parallel wings diminish in width towards the base; they are made of steel, sharpened almost to a razor edge in order to reduce the air-resistance to the utmost, and they are inclined at an angle of 4°. The upper wing is about 1.20 m. long, and the lower only 30 cm. The lifting effect is exerted when the speed attains a rate of 15 km. per hour, and the action is then very rapid. In a few hundred meters the four groups of steel planes come out of the water.

A trial is shortly to be made of a larger machine with a submerged propeller driven by a motor of 120-HP., which will be the first specimen of an industrial water-glider on this principle. It is expected to attain a speed of 100 km. (62 miles) per hour, while the outer wings rest above the water.—A dispatch from Milan, Italy, dated May 15, to the "London Times." An article on hydroplanes or skimming boats appeared in Engineering News, July 8.

A Special Type of Track Construction for Tunnels and Subways.

A new type of track construction is a special feature of the new double track tunnel through Bergen Hill (at Jersey City, N. J.), built by the Delaware, Lackawanna & Western Ry. in connection with the improvement of the approach to its terminals on the Hudson River. The track consists, in brief, of a concrete bed having recesses or pockets for treated wooden blocks to which the rails are attached by clips and screw spikes. The construction presents the following distinct advantages:

(1) It ensures a permanent surface and alinement of the rails. (2) The cost of the regular labor maintenance as required with ballasted track is reduced to track inspection. (3) The renewal of the blocks is much simpler, safer and more economical than the renewal of ties; especially in view of the necessary protection of traffic and trackmen while work is being done, and with the consequent tamping and dressing of ballast required with ordinary track. (4) With the perfect surface and alinement maintained by this system the track materials will have a longer life.

FIG. 1. SPECIAL TRACK CONSTRUCTION IN THE NEW BERGEN HILL TUNNEL OF THE DELAWARE, LACKAWANNA & WESTERN R. R.

(Lincoln Bush, M. Am. Soc. C. E.; Inventor.)

(Each track has a concrete bed with a row of creosoted blocks set in recesses on each side to hold the rails, which are secured by screw spikes and clips.)

The question of permanent track construction for tunnels and underground railways was dealt with at some length in our issues of Aug. 2, 1906 (pages 113 and 123), and Sept. 20, 1906 (pages 310 and 314).

In railway tunnels and subways there are special opportunities for and advantages in the adoption of a more permanent, sanitary and stable system of track construction than that ordinarily used on the open roadbed. As the tunnel has a solid floor, in the shape of a rock bottom or a masonry invert, there is no necessity for the use of a bed of loose ballast to permit of making good any deflections due to settlement of the roadbed. The ballast itself is a cause of deflection in the track, owing to its disintegration, movement and settlement under the influence of weight and vibration due to the traffic. Experience has shown also, that a ballast bed is not necessarily an essential for an easy riding track.

Track construction with a concrete roadbed and without ballast has been used in some submarine tunnels and underground railways, but we believe the Bergen Hill tunnel of the Del-

ware, Lackawanna & Western Ry. is the first case in which this type of track has been used in an ordinary railway tunnel. Fig. 1 is a view of the track at one of the open shafts in the tunnel. At the left is the old double-track tunnel. The new tunnel was opened for traffic Feb. 15, 1909. This track has proved very easy-riding for trains and passengers, with no objections from noise and vibration. It has been in service under heavy traffic for practically five months. The designer states that a very careful inspection made on July 8 shows that there has not been any movement whatever of the tie blocks, and no defects of any character could be found. One noticeable feature is that the tie-plates have not settled into or abraded the wood to any perceptible extent.

The tunnel in question is 4,280 ft. long, driven through solid rock and lined with 2 ft. of concrete. It has a width of 30 ft. between vertical sides and a center height of 24 ft. 11 ins. from the base of the concrete bed to the crown of the semi-circular arch, with the floor of the tunnel cambered 6 ins. at the middle. The two tracks are spaced 13 ft. c. to c. and the details of their construction are shown in Fig. 2.

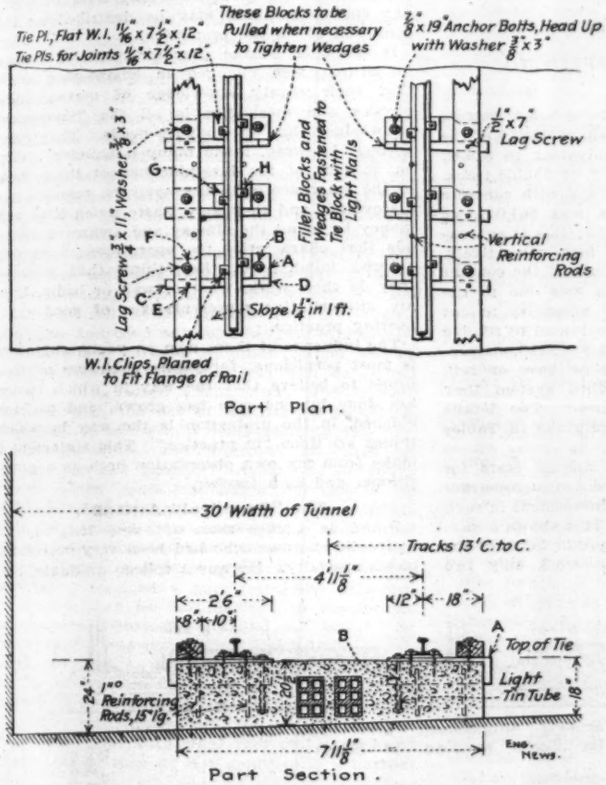


FIG. 2. CROSS SECTION OF SPECIAL TRACK CONSTRUCTION OF THE BERGEN HILL TUNNEL.

Upon the rock floor of the tunnel are two continuous beds of concrete, approximately 8 ft. wide and 20 ins. thick, with the concrete between the tie-blocks reinforced by means of vertical rods against longitudinal stresses that may arise from the driving of wedges or creeping of track. Conduits for electric wires are embedded in the concrete, being thus conveniently and economically placed while reducing the quantity of concrete at a part of the roadbed which carries practically no load. The top of the concrete has a slope of ¼ in. per ft. each way from the center line, and is thus kept clear of the base of the rails. The lower part of the bed is composed of 1 part Portland cement to 12 parts of crushed stone and sand, large coarse stone also having been used to reduce the volume of concrete. The upper part is a 1:6 mixture of cement and Cow Bay (Long Island) gravel, mixed fairly wet. After the track was completed, the concrete was allowed to set for a month before the tunnel was opened to traffic.

Along each side of the concrete bed are recesses or pockets about 22 ins. apart c. to c., to receive wooden blocks (A) which are held in place by anchor bolts (B), wedges (C) and a shoulder in the recess. The tops of the blocks are about 1¼ ins. above the surface of the concrete; steel tie-plates on these blocks support the rails. Upon the ends of the blocks are laid guard timbers 6 × 8 ins. This is a desirable protection with tracks carried above the floor in a railway tunnel having heavy traffic with heavy wheel loading, and where a slight deviation of a derailed train might cause it to strike the tunnel wall or foul a train on the adjacent track.

The principal parts of the track are shown in detail in Fig. 3. The wooden blocks (A) are 30 ins. long, 8 × 8 ins. in section, dressed to 7⅞ × 7¾ ins. They are notched at one side to make a dovetail fit in the pocket, which thus prevents any lateral movement. Each block is secured to the concrete by a ⅞-in. anchor bolt (B), which is fitted with a standard nut for a 1¼-in. bolt. Over the bolt is slipped a light tin tube or sleeve, when the concrete is being deposited, and the bolt is set in the concrete with its head flush with the top of the wooden block. When the concrete has set, the bolt is removed, a ⅝-in. washer is placed under its head, and the bolt is replaced and screwed into the nut. This arrangement provides for sufficient adjustment in the future by screwing the bolt down into the nut. The blocks, anchor bolts, wedges, etc., are set in place in the forms, and the concrete is deposited around them.

A wooden wedge (C) is placed against one side to hold the block in position in the pocket, to take up lost motion due to shrinkage or wear, and to enable a tie-block to be replaced without raising the rail, interfering with traffic or disturbing the adjacent tie-block fastenings. The vertical filler (D) at the end of the wedge is removed whenever it becomes necessary to drive in the wedge, in order to take up any looseness due to shrinkage or wear. The filler and wedge are fastened to the block with light nails to hold them in position when concrete is being deposited, and each wedge is secured by a lag screw (E), which is put through the guard timber and extends about 2 ins. into the wedge. The guard timber is fastened to each block by a larger lag screw (F). The rail blocks and wedges are of long-leaf yellow pine, treated (after being dressed to shape) with 12 lbs. of creosote per cu. ft.

On each block is a flat wrought-iron tie-plate (G) having four 15-16-in. holes for screw spikes. Only two of these holes are used at a time; the other two can be used should the wood become defective or a screw break at the first holes used. A modified design of plate for use where the guard rails are omitted, is made long enough to cover the wedge as well as the block, and has an additional 9-16-in. hole for a lag screw ⅛ × 2¾ ins. to hold the wedge. The screw spikes (H) which form the rail fastenings do not hold the rails direct by mushroom heads, but have standard square heads and are fitted with square clips (J). The rail flange bears directly against the clip and does not wear or cut the screw spikes, as it would were it in direct contact with the spikes. These clips are cut from bars planed to fit the rail flanges. The clips are ¾-in. thick at intermediate blocks and 1-in. at the joints, the greater thickness giving the necessary extra height to hold the flange of the splice bar. Before the spike is screwed home, the thread is well greased or the hole filled with hot creosote oil.

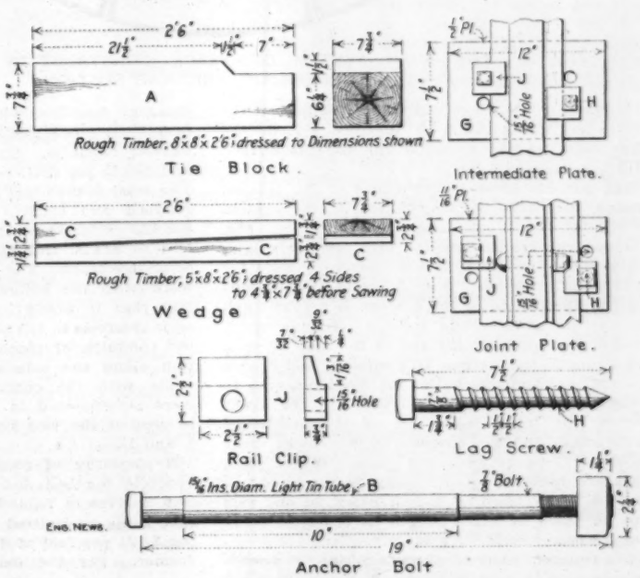


FIG. 3. DETAILS OF SPECIAL TRACK CONSTRUCTION FOR TUNNELS AND SUBWAYS.

When a block is to be removed, a timber shim is placed on each side of the block between the rail and the top of the concrete, to support the weight of traffic on the rail. The fastenings are then removed. The wedge is then withdrawn, and the block is moved back until its larger end clears the shoulder of the pocket, so that it can be pulled out. This is done without disturbing

TABLE I.—ESTIMATE OF COST FOR ORDINARY BALLASTED TRACK IN THE NEW BERGEN HILL TUNNEL (4,280 FT.); DELAWARE, LACKAWANNA & WESTERN RY.

232	gross tons 91-lb. special open-hearth rail,	at $34.00	$7,888.00
520	pairs of angle bars	" 1.07	556.40
3,120	splice bolts	" .03⅓	104.00
3,120	nut locks	" .009	28.08
8,835	tie-plates, 6 × 9 × ½-in.	" .131	1,157.38
520	joint tie-plates, 6 × 11 × ½-in.	" .171	88.92
18,710	spikes	" .01⅔	327.42
4,677	creosoted y. p. ties, 7 × 9 ins. 8½ ft.	" 2.10	9,821.70
6,737	cu. yds. stone ballast, delivered	" 1.00	6,737.00
17,976	lin. ft. of vitrified 6-hole conduits, 5% allowed for breakage	" .225	4,044.60
5,720	yds. drilling for wrapping conduit joints	" .095	543.40
2,035	cu. yds. rock excavation for tile drains	" 7.00	14,245.00
8,988	lin. ft. of 8-in. drain tile; 5% added for breakage	" .085	763.97
2,000	cu. yds. of extra concrete for conduits	" 6.25	12,500.00
8,560	lin. ft. single track laying and surfacing	" .20	1,712.00
586	lin. ft. concrete voids, occupied by conduits, but charged for by contractor	" 3.50	2,051.00
	Total		$62,568.87
	Total, exclusive of conduits		$43,429.87

Total per foot of double track: $14.62 including conduits; $10.15 exclusive of conduits.

the other block fastenings and without interfering with traffic. One man can easily make the renewal. With the ordinary type of track, a gang of men is required to renew ties and perform the necessary digging out and tamping of ballast. In a tunnel or subway this latter method of renewals is a matter of difficulty and large relative expense, as well as of danger.

The system of track construction described above is the invention of (and has been patented by) Mr. Lincoln Bush, M. Am. Soc. C. E., Consulting Engineer, New York, and we are indebted to him for drawings and information respecting this system. Mr. Bush was Chief Engineer of the Delaware, Lackawanna & Western Ry. at the time when its new terminal line and the Bergen Hill tunnel were built.

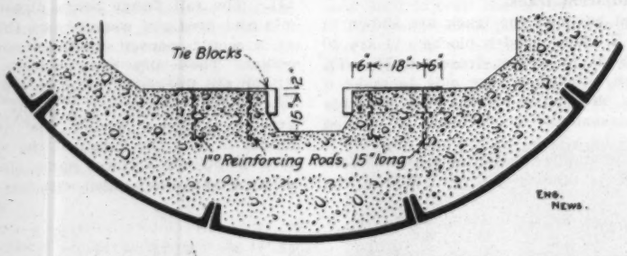


FIG. 4. THE BUSH SYSTEM OF TRACK CONSTRUCTION AS ADAPTED TO TUNNELS OF CIRCULAR SECTION.

The patents cover modifications of the general design, and also the application of the system to special classes of tunnels and subways. Fig. 4 shows the system adapted to a circular single-track tunnel of the type very generally used for submarine crossings. Fig. 5 shows two designs for the application of the system to a four-track subway or underground railway. In the upper design, the track drains are at the side of each track (as in the Bergen Hill tunnel), and enable the removal and renewal of the wooden blocks to be made from outside the track. In the lower design, the track drains are in the middle of each track, and the renewal of the blocks must be done from between the rails. Where such lines are operated by electricity on the third-rail system, every third or fourth block on one side can be made of extra length in order to carry the conductor rail.

The concrete roadbed gives facilities for sweeping and flushing the floor to remove dust and refuse, and experience with underground rapid-transit railways has shown the necessity of thus cleaning the roadbed in order to avoid dust, unpleasant odors and unhygienic conditions. It is stated that creosoted timber for use in subways and "tube" tunnels should be piled and left exposed to summer sun and air for three or four months, in order to permit vapors to escape and thus avoid the heavy smell of the creosote oil.

The estimated cost of the ordinary type of ballasted track for the Bergen Hill tunnel (4,280 ft.), including electric conduits and two lines of drainage trenches, with tile drains below bottom of ballast, was $62,569, or $43,430 exclusive of the electric conduits. This is equivalent to $14.62 and $10.15 per foot, respectively, of double track. The total actual cost of the track with concrete roadbed and electric conduits was $61,011, or $56,423 exclusive of the conduits; this is equivalent to $14.26 and $13.18 per foot, respectively, of double track. The greater cost of the conduit work with the ballasted track was due to the fact that it would have been necessary to cut rock channels in the side of the tunnel to receive the conduits, or place them in special construction along the side walls, below base of rail, while with the concrete roadbed system they were incorporated in the concrete. The details of cost of the two systems are given in Tables I. and II.

A summary of comparative annual costs for concrete roadbed and ballasted track construction is given in Table III., the investment in each case being capitalized at 4%. This shows a saving $1.21 per foot of double track in favor of the former. For the maintenance work only two track inspectors have been employed (one by day and one at night), at $45 per month. With the ballasted track in the old double-track tunnel (which is paralleled by the new tunnel) the labor cost for the year 1908 was $565 per month, as follows: $75 for foreman, $400 for laborers and $90 for watchmen.

TABLE II.—ACTUAL COST OF SPECIAL TRACK CONSTRUCTION WITH CONCRETE ROADBED IN THE NEW BERGEN HILL TUNNEL (4,280 FT.); DELAWARE, LACKAWANNA & WESTERN RY.

232	gross tons 91-lb. special open-hearth rail	at	$34.00	$7,888.00
250	pairs of angle bars	"	1.07	556.40
3,120	splice bolts	"	.03½	104.00
3,120	nut locks	"	.009	28.08
8,835	tie-plates, 6 × 9 × ½-in.	"	.131	1,157.38
520	joint tie-plates, 6 × 11 × ½-in.	"	.171	88.92
17,976	lin. ft. vitrified 6-hole conduit, 5% allowed for breakage	"	.225	4,044.60
5,720	yds. drilling for wrapping conduit joints	"	.095	543.40
9,360	creosoted y. p. tie blocks, 8 × 8 × 30 ins.	"	45.00	5,616.00
9,360	creosoted y. p. wedges, 2¼ × 8 × 30 ins.	"	45.00	1,579.50
17,680	intermediate rail clips	"	.039	689.52
18,720	pieces round iron 1 × 15 ins. for reinforcement	"	.06⅓	1,185.60
1,040	joint rail clips	"	.051	53.04
18,720	lag screwspikes, ¾ × 7½ ins.	"	.046	861.12
9,360	lag screws for guard rail, ⅝ × 11 ins.	"	.034	318.24
9,360	washers for guard rail, ⅝ × 3 ins.	"	.03	280.80
9,360	wedge lag screws, ½ × 7 ins.	"	.013	121.68
18,555	lin. ft. of y. p. creosoted guard rail, 5 × 8 ins.	"	45.00	2,783.25
4,680	guard rail anchor bolts, ⅞ × 18 ins.	"	.08⅔	405.60
4,680	guard rail washers, ⅝ × 3 ins.	"	.03	140.40
4,680	anchor nuts, 2¼ ins. sq. × 1¼ ins. thick	"	.08	374.40
4,680	tin tubes for anchor bolts	"	.005	23.40
3,754.4	cu. yds. concrete	"	6.25	23,465.00
1,019.2	cu. yds. concrete voids, occupied by tie blocks, wedges and conduits, but charged for by contractor	"	3.50	3,567.20
Labor	and engineering for assembling and fastening complete, tie blocks, wedges, guard rails, rail, rail joints, screws, screw-spikes, etc., 8,560 lin. ft.	"	.60	5,136.00
	Total			$61,011.53
	Total, exclusive of conduits			$56,423.53

Total per foot of double track: $14.26 including conduits; $13.18 exclusive of conduits.

TABLE III.—COMPARATIVE ANNUAL COST.

Type of track.	Interest on investment.	Track maintenance.	Total.	Total per mile.
Concrete roadbed:				
With conduits....($61,011)	$2,440	$1,080	$3,520	$4,344
Without conduits.($56,423)	2,257	1,080	3,337	4,118
Ballasted track.				
With conduits....($62,569)	2,503	6,780	9,283	11,451
Without conduits.($43,430)	1,737	6,780	8,517	10,507

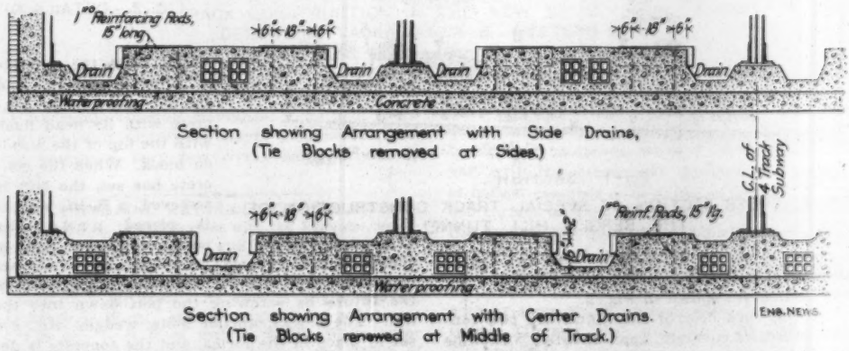


FIG. 5. THE BUSH SYSTEM OF TRACK CONSTRUCTION AS ADAPTED TO A FOUR-TRACK RAPID-TRANSIT SUBWAY.

Engineering Science and the "Practical Man" in Engineering.

By ANTONIO LLANO.*

More than half a century has elapsed since Rankine, in the "Dissertation" prefixed to his classical work on "Applied Mechanics," found it necessary to point out the fallacy, bequeathed to us by the philosophers of antiquity and by the schoolmen, that there is a radical antagonism between scientific knowledge and practical knowledge. He lamented the fact that this fallacy was not yet dead and forgotten. Were he living now, he would find, at least in our country, little to make him change the substance of what he then wrote. We have indeed many men who are at the same time eminent practitioners and profound scientists; and we have many engineers who are guided in the exercise of their profession by those scientific principles and methods that the ignorant contemptuously call "theory." But it must be confessed that such men form but a small minority, especially among that numerous class of average engineers which may be described as the rank and file of the profession.

It seems to be the prevailing opinion among uncultured men engaged in engineering work that their scanty knowledge of mathematics, physics and mechanics is all the "theoretical knowledge" that an engineer needs. They may, without knowing, make many a blunder which, on account of the insignificance of their work or the ignorance of their employers, remains undiscovered; and they may waste much time and money by using the clumsy and awkward methods that characterize the operations of an untutored mind. Yet they think that because they do their work, whether well or badly, they are authoritative representatives of good engineering practice.

The influence of these men on young engineers is most pernicious; for young engineers are too prone to believe that the way in which things are done by one who has grown, and perhaps oldened, in the profession is the way in which things are done "in practice." This statement I make from my own observation both as a practitioner and as a teacher.

The "Practical" Attitude.

I had as a co-worker, not very long ago, a hydraulic engineer who had been very successful in his specialty. He was a college graduate, but prided himself on having banished from his mind all the "theory" he had learned in college; for, as he said, he had found that practical men do everything by means of a few tables and one or two pocketbooks. He had designed several water-works, filled some important positions, and been praised by city and town officials, and even by engineers of high standing; and his ability seemed to be further attested by the fact that he was a member of the American Society of Civil Engineers.

This man, in designing a pipe line that divided into two branches between the source of supply and the points of delivery, computed the velocity and discharge at the point of bifurcation

*Scranton, Pa.

by the same formulas (or tables) that give those quantities for a pipe discharging freely into the open air; that is, he applied the same rules to water discharging against pressure that are used for water discharging into the atmosphere. His method of designing a conical foundation for a standpipe was to determine, by a pocketbook formula, the dimensions of a cylindrical foundation that would satisfy the conditions, and then to "transform," as he said, the resulting cylinder into a conical frustum having the same *weight*; his idea being that stability depended on weight only. In plotting an equation of the form $y^2 = a\ x$, he would make the ordinates proportional to the abscissas, apparently not knowing the difference between a straight-line formula and a parabolic formula.

Yet, he boasted of his ability, and above all, of his practicality, and if any one pointed out his blunders, he would simply say, with an air of superiority: "In practice, things are done in this way. It may be different in theory, but I am a practical man."

If a college graduate can be so influenced by ignorant practitioners, what can be expected of the young man who derives from them all his knowledge or learns under their guidance?

I had once a pupil in surveying whose father was an engineer of some repute in his town. This pupil wished to begin his studies with transit surveying, saying that he had a good practical knowledge of elementary mathematics, and that he had worked as a computer in his father's office, under the direction and instruction of that gentleman. We had not proceeded very far before we came to simple problems in ordinary triangulation. I explained to him the field operations, assuming that he knew how to solve an oblique-angled triangle. I was surprised to see that he divided the triangle into two right-angled triangles, and used natural functions exclusively. I asked him if he knew no other method, and he said he did not. When I told him he should learn a little more trigonometry and become familiar with the use of logarithmic functions, he looked at me with a compassionate and contemptuous smile, and informed me that his father, who had practiced engineering for many years, never used logarithms nor solved an oblique-angled triangle except by dividing it into two right-angled triangles; and he added that he did not wish to learn useless theory, but "how things are done in practice." The following day I received a note from him in which he stated that he had decided to discontinue his lessons. Obviously he and his father had found that I was not a "practical man."

Nor was this an isolated case. Many students object to learning the use of logarithms, adducing as an argument the fact that they know surveyors who thrive very well without burdening their brains with what they call superfluous theory, when they do not apply to it a harsher name.

The majority of so-called practical men, and the public in general, seem to think that an engineer is mainly a man who knows how materials should be mixed and placed, how the members of a structure should be put together, and other similar matters which, although they should no doubt be known by every engineer, are equally well known by every builder and foreman. In the opinion of those who have thus degraded engineering, making of it nothing but a routine "trade," the essential qualification of a mechanical engineer is that he should know how to run an engine; of a railroad engineer, that he should know how to lay or bend a rail, to ballast a track or to remove a tie with his own hands. This is called "practical knowledge," and believed to be *sufficient* knowledge to entitle a man to call himself a member of the profession.

And not infrequently does this mental ailment afflict the minds of engineers of some note, who through their example, and often through their explicit utterances, contribute to the perpetuation of that delusion which, making of scientific knowledge a thing opposed to practical knowledge, has the sad effect of crippling practical knowledge itself. I shall substantiate this statement by referring to the printed books of some prominent engineers; books in which they have plainly shown the conceptions that guide them in their actual work, and the ideas they have regarding the fundamental principles on which their profession is founded. And this will be all the more instructive because from the mental condition of these writers, who are not wholly uneducated, we may infer the chaotic mental condition of the numberless obscure surveyors, designers and others who are governed in their work by this pernicious rule of exaggerated, bigoted and blind practicality.

The "Practical" Man in Engineering Literature.

I have before me a book on a very important engineering subject, written by a man who is regarded as an authority on that subject, and referred to in a technical journal as a "standard work." He too claims to be a practical man; he, too, conceals his lack of scientific knowledge under a lofty denunciation of useless theory; and he shows in the first pages of his book that, although he may be a good builder, a good contractor or a good judge of materials, he is distressingly ignorant of the most rudimentary principles underlying his supposed specialty. In his Introduction, he announces his purpose of presenting

> such facts as may have been verified, freed, as nearly as possible, from the tons of mathematical rubbish which Trautwine asserts frequently bury the simplest truths.

This work relates to a branch of structural engineering, a subject that involves not only the first principles, but some advanced principles, of statics. The author's understanding of those principles, his capacity to apply them, and his ability as a writer, are very plainly shown by the following passages:

> The manner or method of application of a force to a body necessarily comprehends a principle of mechanics known as the "moment" of forces, or the tendency of a force to produce motion about a point. This is an expression representing the power produced by the force to cause motion about a point when acting through the principle of "leverage."
>
> [Should one of two forces acting on a body] exceed the other, equal parts of each force destroy each other, and any excess of one over the other is termed the "resultant" of the two forces; and the direction of this excess, or the resultant of the two forces, is exerted in a line bisecting the original angle at which the forces met, and the extent of the force exerted by this resultant is the difference between that offered by the two or more original forces.

To this writer, "unit-stress" means sometimes ultimate strength, sometimes working strength, but never (or seldom) intensity of stress.

The results of ignorance so great and of confusion of ideas so astounding can readily be anticipated. The manner in which the author applies the principles of mechanics to structural design is most painful: In some cases his conclusions are wrong or inconsistent with the premises he has taken from other books; and in some cases, where he has copied formulas and rules, his interpretation and explanation of them are a veritable chaos.

What confidence can be placed in a man of this kind when he undertakes the design of a structure requiring some originality? Yet, his book has been much printed (for it has already reached a second or third edition), much sold, and much read. And here some questions may be asked, which are not altogether impertinent. How did a reputable publishing house undertake the publication of such a book? Why have reviewers overlooked the properly scientific part of the book, and confined themselves to praising the purely descriptive part? Perhaps because the scientific part, being but "theory," is of no importance whatever?

As another illustration of the style used by some of these exclusively practical engineers when they deal with physical principles and mathematical formulas, I shall quote a few paragraphs from the *fourth* edition of another "standard work," a work written by a man who, besides being a C. E. and a member of the American Society of Civil Engineers, has filled very high offices in the profession.

> The force [water pressure] which tends to overturn or push a surface about a given point is not in the center of gravity of the body of water, but at two-thirds of the depth from the surface to that point, while the center of gravity is at one-half the vertical depth of the point.
>
> The velocity v of a body at the end of a given *space* of time t is equal to the product of time into *its* acceleration by gravity. Thus, $v = g\ t$. It has been shown that the height h through which the body falls, or through which its *pressure* is accelerated, is equal to one-half of the gravity [he has stated previously that, during the first second, $h = \frac{1}{2}\ g$, and perhaps this is what he means], and the heights fallen in any given time are as the squares of the time [how many squares has the given time?]; hence [?] $t = \sqrt{\frac{2h}{g}}$; and substituting, transposing, and eliminating, we have $v = \sqrt{2gh}$! (Italics mine.)

There is nothing essentially wrong in this presentation or review of some simple laws of physics; but, to one familiar with them, the explanation conveys no new idea (except, perhaps, the suspicion that the author himself had *no* idea); to one that knows nothing about them, the explanation is a puzzle; and to one who has a fair knowledge of composition, the explanation will sound like the unholy blasphemies of an unbaptized soul in open revolt against its mother tongue.

And let it not be thought that these are academic matters. For is not mathematics used in actual engineering work? Is not statics used in the design of an actual structure? And is it not very likely that he who, being unfamiliar with even elementary mathematics and statics, undertakes the design of an engineering work of some magnitude requiring the use of mathematics and statics, may make serious blunders resulting in loss of money, and very often in loss of life? How many so-called accidents, if thoroughly investigated, could not be traced to mathematical or other scientific blunders?

Perhaps a concrete example will serve to make these serious possibilities manifest. Not very long ago a prominent hydraulic engineer read a paper before a learned engineering society. The paper was considered so valuable that it was afterwards reproduced in a very pretentious work on a very important branch of hydraulic engineering. The author of the paper, at the "request" of some friends, who no doubt regarded him as a high authority, devoted a great deal of space to the theory and design of fly-wheels. Having defined the moment of inertia of a wheel as the product of the *weight* W and the square of the radius of gyration r, he writes the following equation for the kinetic energy E of the wheel, a being the angular velocity:

$$E = \tfrac{1}{2}\ W\ r^2\ a^2.$$

This formula he gives as the fundamental formula by which a fly-wheel should be designed.

A simple inspection will show at once that the formula, not being homogeneous (by which is meant that the two members cannot represent quantities of the same kind), is impossible, and therefore wrong. He simply copied the usual expression for the energy of a revolving body, but probably did not know that, in that expression, the *mass*, not the weight, of the body should be used; or perhaps he did not know that, although the moment of inertia may be defined in terms of weight, all equations must be made consistent with the definition.

He now proceeds to design a fly-wheel. Instead, however, of using his formula, he uses a pocketbook formula, not noticing that the two formulas are inconsistent with each other. He finds the face (width) of his wheel to be about 18 ins.; but if he had not had a pocketbook and had used his own formula he would have found the required face of the wheel to be ½-in.! This result is so absurd that he naturally would have rejected it; he would have damned formulas, and mathematics, and "theory," and would have guessed, guided by "experience" and "practice," at a more reasonable width, built his wheel accordingly, and exultingly sung the superior knowledge of the "practical man." Unfortunately, errors arising from ignorance of elementary mathematics and mechanics are not always so glaring, and may show themselves only in disastrous results after the work is done.

This writer, who apparently had a smattering of elementary mechanics, a subject on which he discourses very knowingly, affords a curious illustration of how some practical men interpret and manipulate mathematical formulas. From the formula $v = \sqrt{2gh}$ he computes, taking g as 32.2 and h as 9 ft., the value of v to be 24

ft. per sec. Then, applying the formula $t = \frac{v}{g}$, he computes as follows the time required for a certain body of water to fall through a distance of 9 ft. (his interpretation of the meaning of t in the particular problem he is solving is wrong, but I shall overlook that):

$$t = \frac{v}{g} = \frac{24}{32.2} = .7 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

By assuming the weight of water to be 62.4 lbs. per cu. ft., he finds that the weight of the water with which he is dealing is 561.6 lbs. He now proceeds "to make sure that our figures are right." To do so, he computes v from "the fundamental equation"

$$m\,v = F\,t, \text{ or } \frac{W}{g} \times v = F\,t,$$

which gives

$$v = \frac{F\,t}{W \div g} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In this case, he says, $F = W = 561.6$ lbs.; t, as found before, is .7 sec., and, therefore,

$$v = \frac{561.6 \times .7}{561.6 \div 32.2} = 22.6 \text{ ft. per sec.}$$

He is very much puzzled by the fact that this result does not agree with the value 24 he had already found for the velocity; and, evidently not knowing that, when $F = W$, equations (1) and (2) are identical, and that the only reason why he finds 22.6 instead of 24 is that he substituted in (2) the rough approximation found in (1), he devotes a great deal of space to the explanation of the apparent discrepancy. The reasons for the discrepancy, he says, are: first, that, in finding the value of v by the formula $v = \sqrt{2gh}$, $\sqrt{2g}$ was taken as 8.025, which is only a rough approximation; second, that, in finding W, the weight of water per cubic foot was taken as 62.4 lbs., which also is not an exact value. Of course, the values assumed for g and W have nothing whatever to do with the necessary consistency of two different forms of one and the same formula. This, however, was too high an abstraction for this "practical man"; and, after his "practical" explanation, he concludes that, "by using better values" for W and $\sqrt{2gh}$, "we can bring out $v = 23.8$"!

Some Causes of the Prevailing Hyper-practicality.

Having exhibited what may be termed a pathological condition in the engineering profession, or rather, in some of its members, I shall endeavor to point out a few of the principal causes of that condition.

There was a time when the application of science to the physical wants of man, and the employment of knowledge as a means of procuring a livelihood, were regarded as a degradation of the lofty objects of pure reason. "Archimedes," says Rankine, "to the character of the first geometer and arithmetician of his day, might add that of the first mechanician and physicist; he might, by his unaided strength acting through suitable machinery, move a loaded ship on dry land; he might contrive and execute deadly engines of war, of which even the Roman soldiers stood in dread; he might, with an art afterwards regarded as fabulous till it was revived by Buffon, burn fleets with the concentrated sunbeams. But that mechanical knowledge and that practical skill, which in our eyes make that great man so illustrious, were by men of learning, his contemporaries and successors, regarded as accomplishments of an inferior order, to which the philosopher, from the height of geometrical abstraction, condescended, with a view to the service of the state."

In modern times, there has been a strong reaction against this irrational attitude of the ancients; but the reaction, as often happens when man shakes off a yoke that has oppressed him for many centuries, has been too violent. By the law of oscillation, the pendulum has swung to the opposite extreme, and we have come to attach so great importance to the practical applications of science that we often regard them as independent of science itself, thus forgetting, in our eagerness to attain an end, the only means by which that end can be truly and surely attained. In our efforts to emphasize the value of practical knowledge, we are apt to place scientific knowledge in the background, as a thing of very little usefulness. Education itself is by many considered as exclusively a device for moneymaking, and study as exclusively a commercial investment. Such exaggerated teachings necessarily produce an attitude of mind which, to say nothing of its morally materialistic effects, tends to narrow the limits of scientific training, thereby greatly impairing that utilitarian value itself which is regarded as the only value of education.

It is to-day a generally accepted axiom among educated technical men that theory and practice, far from being irreconcilable foes, are the necessary complements each of the other; and that neither a lifetime of book study nor a lifetime of blind experience is sufficient to make a competent, reliable practitioner. These two forms of activity are but two branches of the same tree; or, perhaps, we may more properly say that one is the root, and the other the trunk; and that neither can the trunk bear fruit without the root, nor the root fructify without the trunk. Yet, these educated men themselves, while recognizing the truth of the axiom in the abstract, and knowing from their own experience the necessity of the harmony and interdependence that must exist between scientific knowledge and good practical work, allow their praise of experiential knowledge to *appear* so unqualified that the student and the beginner are misled into the belief, and the ignorant practitioner is strengthened in the conviction, that all scientific knowledge, being barren, is unprofitable.

The early editions of Trautwine's "Pocket-book" afford a good illustration of this unwise, uncautious, exaggerated defense of empiricism; and this notwithstanding that he was himself an advocate of what he thought a good training in fundamental principles. He says in the Preface:

> It is the ignorance of these principles, so easily taught even to children, that constitutes what is popularly called "the practical engineer"; which, in the great majority of cases, means simply an ignoramus, who blunders along without knowing any other reason for what he does than that he has seen it done so before. And it is this same ignorance that causes employers to prefer this practical man to one who is conversant with principles. They turn up their noses at science, not dreaming that the word means simply *knowing why*. And it must be confessed that they are not altogether without reason; for the savants appear to prepare their books with the express object of preventing purchasers (they have but few *readers*) from learning why.

The last part of this paragraph already shows that hostility which Trautwine, as a practical man, showed towards such scientific engineers as Rankine and Weisbach, to whom he seldom refers without contemptuously calling them "savants." In denouncing these men and their classical works, to which *practical* engineering owes so much, he was, perhaps unconsciously, encouraging the blundering "ignoramus" that he had previously condemned. I shall copy the last lines of his Preface, which have been often quoted by "practical men" as a defense of ignorance, and which, in my opinion, ought to be eliminated by the editors and revisers, since the ideas there expressed are both obsolete and harmful:

> The writer does not include [among authors to be recommended] Rankine, Moseley and Weisbach, because, although their books are the productions of master minds, and exhibit a profundity of knowledge beyond the reach of ordinary men, yet their language is so profound that very few engineers can read them. The writer himself, having long since forgotten the little higher mathematics he once knew, cannot. To him they are but little more than striking instances of how completely the most simple facts may be buried out of sight under heaps of mathematical rubbish.

It may be well to remark further that, although Trautwine was an advocate of technical education, he narrowed its sphere within too narrow limits, stating that

> nearly all the scientific principles which constitute the foundation of civil engineering are susceptible of complete and satisfactory explanation to any person who really possesses only so much elementary knowledge of arithmetic and natural philosophy as is supposed to be taught to boys of twelve or fourteen in our public schools.

Every educated engineer knows that this is not true to-day. Nor was it true even in Trautwine's time; and he himself, owing to his disregard of "mathematical rubbish," fell into very serious errors in the treatment of some mechanical principles. Of course, he was a pioneer, and it was perhaps natural that he should slip occasionally. I have called attention to his extreme views merely because they exemplify the danger of carrying the spirit of practicability too far, and because they still exert a powerful influence among certain classes.

Another very powerful source of influence is found in the technical journals, which can do much harm or much good in educational matters and in the presentation of what should be considered the proper sphere of action and the necessary qualifications of an engineer. Nearly all the editors of our leading engineering periodicals are both men of science and men of action, and they are competent to discuss, with equal ability, the constructive details of a structure and the fundamental principles that underlie its design. Yet they too overemphasize the importance of empirical knowledge, both explicitly in their direct utterances on educational matters, and implicitly in the character of their publications. When a new building, bridge, dam or sewer is constructed, the minutest details of its parts are fully described and profusely illustrated by sections, photographs and perspective drawings; but only occasionally, and only in a few journals, are the principles given by which the structure was designed. And this notwithstanding the fact that the design may have presented peculiar problems and the use of special methods which, if published, would be of great value to all practitioners. Nor is this all. Were it the custom to present the scientific principles involved and employed, and the manner of their application, much of the bad work that parades under the name of engineering work would have been killed at its birth, and many an ignoramus that parades under the name of engineer would be prevented from robbing the public and disgracing the profession.

There are some would-be technical journals (I have seen one at least) devoted almost exclusively to the condemnation of education and to the defense of unaided or unsupplemented practice as the best and only means of making good engineers. Such publications rank, of course, very low in engineering literature, and probably that is why they go unnoticed by authoritative journals and writers. It should be borne in mind, however, that they have a wide circulation among those classes that are most likely to be influenced by them. The high-class journals ought, therefore, to denounce, explicitly and without reserve, all publications of that type, and warn the masses of engineering workers against teachings that are as pernicious as they are fallacious.

And even the leading journals themselves occasionally publish long letters from men who claim to be self-made, almost uneducated, and still successful practitioners, and who by implication present themselves as samples of the true engineer and as living evidences that technical education is of little or no value. Some of these practical men, in whom vulgarity seems to accompany practicality, would impress upon the reader, by bad-taste vaudevillian jokes and gross exaggerations that are plain lies, that the profession of an engineer is not consistent even with the refinement and good breeding of a gentleman. Such letters ought not to be published, or ought to be published with the strong and contemptuous editorial condemnation which they deserve. They ought to be treated as a serious philosophical journal would treat a defense of astrology or a demonstration that hell is a soul-boiling caldron.

And it should be further kept in mind that, on account of the lack of regulation in the practice of engineering, and of the general carelessness with which much of our work is done, the fact that a man has been successful does not prove his competence. Witness the hydraulic engineer mentioned at the beginning of this article. Nor does the fact that thousands of men have been doing a certain thing in a certain manner for

hundreds of years prove that that is the best way to do that thing. Witness the multitudes of surveyors that do not know the use of logarithms.

The underrating of scientific knowledge appears also in proposed schemes to subordinate the teaching of science to practical requirements. Especially is this the case with the teaching of mathematics. Misguided by crude conceptions of practicality, some writers imagine that in order to make mathematics "practical" it is necessary and sufficient to illustrate principles by "practical" examples; and by this they mean that instead of asking a student of engineering, while he is learning arithmetic, to find the sum of 3 apples and 10 apples, we should ask him to find the sum of 3 foot-pounds and 10 foot-pounds, or perhaps of 3 volts and 10 volts; and that, in explaining the principles of the calculus, the text-book writer and the teacher should search the whole field of engineering for appropriate applications: it matters not that these applications are taken from higher geodesy or from the most recondite domains of electricity and thermodynamics, subjects that the student cannot grasp before he is master of the calculus itself: the important thing seems to be to employ "practical" terms and solve "practical" problems, although both the terms and the real import of the problems may be like Hebrew to the struggling student.

There is no doubt that all branches of mathematics lend themselves to a treatment in which abstract propositions and formulas can be exemplified by such concrete illustrations relating to physics and engineering as can be reasonably assumed to be within the student's reach; and this treatment, if judiciously employed, is much to be commended. But in this, as in all else, wisdom requires discrimination, lest a sound principle should be extended beyond the limits of its applicability, and made to serve methods that are at once inefficient, incongruous and illogical. And here we have another evil effect of the gospel of practicality. This gospel has been so sweepingly and so loudly preached, that even the pure mathematician has been awed into submission by its popularity; and he believes it his duty to satisfy the ambition of those who think that all things can be learned at once. The uneducated practical man, not knowing the necessary interdependence and subordination of engineering subjects, is apt to think that he can learn the higher branches without learning the lower, or can learn them at the same time as the lower. This error, perhaps somewhat purified and in a form not so gross, is at the bottom of the conception that some educators, or would-be educators, have of what a "practical" text-book ought to be.*

Some Suggestions.

The words "theory" and "theoretical" are so commonly misapplied, and there are so many persons in whose minds they evoke erroneous associations, that it would be advisable to banish them from the vocabulary of engineering. In reality, a "theoretical" engineering formula does not differ from a "practical" formula; or rather, they may both be called either theoretical or practical; or, better still, neither term has any meaning; since it seems to imply a distinction that does not exist. The formula $v = \sqrt{2gh}$ is as empirical as the formula $v = .96\sqrt{2gh}$, and the latter is as theoretical as the former; only they apply to different conditions. The factor g is no less empirical than the factor .96, although the former can be more readily obtained than the latter, and its variations can be more easily and simply formulated. All laws of physics are ultimately founded on observation, experience and experiment, and therefore all formulas relating to these laws are, from their very nature, empirical. If any one applies a formula to conditions to which the formula does not apply, and is disappointed at the result, let him blame himself for his ignorance, and not the mathematician for his theory.

Above all, let it be remembered that the man of no education, or of little education, is easily led into unwarranted generalizations, and that, from the constant overstress laid on the value of practice, he may conclude, to his own detriment and to the detriment of the profession, that science is an oppressive yoke, or perhaps only a gaudy ornament.

The beginner should be careful as to whom he takes counsel with. He should remember that, as I have already stated, *practice* and *good practice* are not synonymous; that many things done "in practice" ought not to be done, or ought to be done differently; and that success is not by itself a certain sign of ability. He should regard with distrust the man who, claiming to be a good engineer, boasts of his ignorance of mathematics; for that man is likely to know engineering no more than a quack doctor knows medicine.

As to the uneducated or half-educated practical man, he ought to cultivate, if only on utilitarian grounds, the virtue of modesty, and not to fall into the error of believing that no one needs to know more than he knows, nor undertake to belittle those parts of science about which he, being ignorant, cannot express an intelligent opinion. Before a practical surveyor who has never used logarithms and who regards his traverse table as all-sufficient sets down logarithmic computation as "mathematical rubbish," let him consult another practical surveyor (not a pure mathematician that has never taken a bearing nor read a transit) who is familiar with this method of calculation, and who is, therefore, competent to judge of its practical value. Before a bridge "engineer" (I abuse the name) that knows nothing about sigmas, x's and y's declares that these are worthless things never used "in practice," let him consult a bridge engineer that knows the application of sigmas, x's and y's. For it is plain that one cannot judge of those things of which one has no knowledge; and he who disregards this obvious truth blocks his own way to progress, and often the way of others, besides bringing upon himself the ridicule that justly falls upon conceited ignorance.

*I have received hundreds of letters from men who, being unfamiliar with even arithmetic, wish to know how to design a bridge, a dam, an arch, a pumping plant or a water-works. And I may add, as a further example of the facility with which an ignoramus can practice (because he is allowed to practice) engineering, that some of these letters are written by men in charge of comparatively important work. The very questions that they ask betray their incompetence. They will ask such questions as these: "How do you figure the discharge of an 18-in. pipe?" "How heavy a load can a 12-in. I-beam carry?" They do not give the head nor the length of pipe in the former case, nor the weight nor length of beam in the latter, apparently not knowing that these quantities have any bearing on the problem. Who can tell how much minor engineering work is done by men of this type? And is not the fact that such men are allowed to call themselves engineers and to practice engineering the reason, or at least one of the main reasons, why engineering ranks so low among the professions, whereas it ought to rank with the highest? And is not the fact that engineering ranks so low the reason, or at least one of the main reasons, why the engineer is, as a rule, so scantily remunerated?

Wrecking a 150-Ft. Chimney.

By C. H. LAWRENCE.*

The large chimney of the Purdue University power plant recently developed several dangerous cracks, about half way to the top, and through these smoke would find its way when the wind was from the right quarter. After an unsuccessful attempt to repair the stack it was decided to remove it and to build a new one. The chimney was 150 ft. high, had a base section 20 × 20 ft., 33 ft. high and was 18 ft. in diameter at the base of the round stack.

The chimney was to be thrown and in a certain closely fixed direction on account of the proximity of the neighboring buildings. A breach, about 2 ft. high, was cut some three-quarters of the way around and just above the base section, as shown in the accompanying figures. As the bricks were removed, oil-soaked wood blocks were put in. Six blocks, 8 × 8 ins., 2 ft. long, were used. When preparations for the fall were complete the opening was filled with kindling wood and the blocking was burned out. It required about three-quarters of an hour to burn away this blocking, and the fire in the breach had to be replenished meantime.

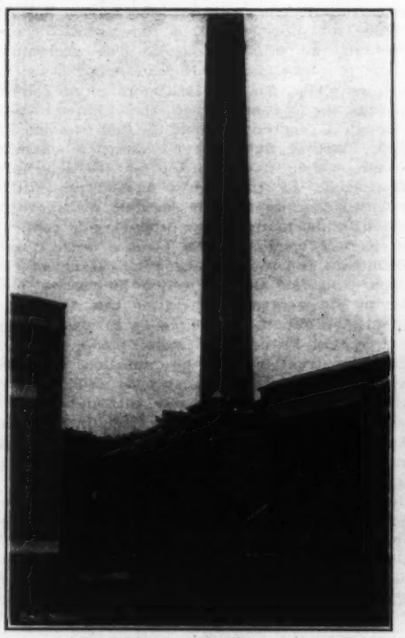


Fig. 1. Blocking a Breach at the Base.

Fig. 2. Just After Failure of the Blocking.

FIGS. 1 AND 2. THROWING DOWN THE 150-FT. CHIMNEY AT THE PURDUE UNIVERSITY POWER PLANT.

A rope was fastened to the top of the stack and, by pulling on this while the blocking was burning, the fall was started in the right direction. The wreck fell almost exactly on the desired spot. The only damage done was to the adjacent corner of the power-house, and was comparatively slight. One peculiarity of the fall was noted. After the stack had reached the position shown in Fig. 2, it appeared to crumble all at once and to come down as a heap of separate bricks.

An examination of the debris showed that a large proportion of the bricks were blackened on two or more sides, indicating that the bond had been broken so that smoke entered between the bricks.

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An Aerating and Flushing System for Percolating Sewage Filters.

By WM. GAVIN TAYLOR, M. Am. Soc. C. E.

A recent article by Dr. Rudolph Hering (Eng. News, May 6, 1909, p. 493) forcibly emphasizes the vital necessity of furnishing to sewage, during its purification by percolating through the bacteria-coated media of a sprinkling filter, a large volume of air from which a percentage of oxygen may be absorbed for the betterment of the effluent. Lack of appreciation of this feature is certain to cause the failure of plants so constructed that an efficient oxygenation of the passing sewage is impossible. Recently the writer

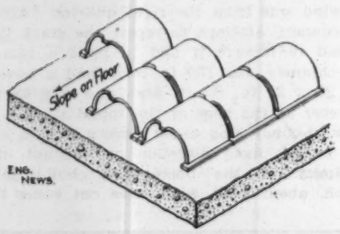

Fig. 1. A Type of False Flooring for Percolating Sewage Filters at Birmingham, England (After Raikes).

examined the proposed plans of several small installations in which absolutely no provision was made for aeration and no proper facilities were provided for the collection of the effluent, or for the flushing of the floor system or the filtering medium.

Designers ought not to underestimate the essential need of a highly efficient false floor system in percolating filters, which should be so arranged as to permit a free and a nearly vertical passage for the applied sewage and its accumulating load of suspended matter desquamating from the filter material, from the surface to the true floor of the filter. The false flooring should offer a free path for sewage and for air without the necessity of a marked horizontal flow of either through the media, because any direct lateral movement of the sewage through the interstices tends to cause a deposition of the suspended load and an ultimate clogging. The effluent, upon reaching the true flooring, should find a smooth surface, and a straight and rapid run to the collecting channel. A vertical flushing of the filling material with a strong stream of either purified sewage or a cleaner water should be possible, so that, in case of need, the major portion of retained suspended

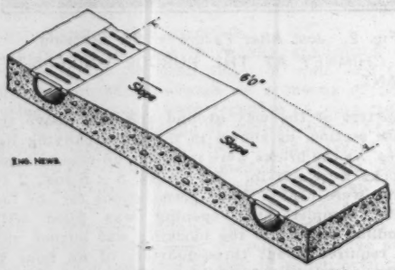

Fig. 2. False Floor for Percolating Filters at Hanley, England.

matters and dried bacterial growths may be washed downward through the filling medium, passing the false flooring to the true floor, and thence to the effluent collectors. The entire surface of the true floor and the effluent collectors should also be within the flushing system. And a free exchange of air through the effluent channels, the inter-space between the false and true flooring, and the entire interstitial space of the filter is needful for high nitrification.

The specific aid and influence of these features have been sufficiently shown at several municipal sewage-testing stations and working plants, both in America and abroad, to justify a careful planning and construction of the parts, yet the particular importance of the subject has not been generally appreciated.

Rideal in testifying before the Royal Commission on Sewage Disposal has said in effect that the aeration of a bacterial bed was of sufficient importance to warrant the supplying of an interchange of air through artificial ventilation (Q. 4204).

The detailed construction of the drainage and false floor system in percolating filters has varied widely, but perhaps the most common form, certainly the most common in this country, has been the placing of plain or special half round tile or channel pipes, in a convex position, longitudinally with the slope of the true filter floor. A floor of this type as used at Birmingham, England, is shown in Fig. 1.

In certain cases no special means have been provided for a positive flushing of the floor system or for an acceleration in the interchange of interstitial air except such small amount as might be induced through the effluent conduit. In other cases the channel pipes or the floor system has been extended to the exterior of the filter wall or material where free access to air currents is obtained, thus producing a constant aeration of the inter-space between the false and true flooring but not necessarily inducing either an upward or a downward current through the filter material. The preliminary plans presented in the Report of Advisory Engineers (1906) for the Baltimore plant contemplated the extension of the channel pipes through a concrete wall, at the end of each floor slope, into a flushing and aeration chamber, within which every portion of the true filter floor could be thoroughly flushed, and either downward or upward air currents set up within the filtering material by producing a condition of partial vacuum or a plenum within these chambers and taking other necessary precautions. So far as the writer knows no plant having an aeration system of this type is in operation, but the principle is so positive and simple that its complete success seems assured. The construction of the aeration chambers within or between the filter beds adds considerably to the cost of the works, although this cost will not prove a burden to large installations. Another general method has been used in England, to some extent, in which channel pipes are laid in a concave position, in parallel lines in the floor, the edges of the channels being slightly below the floor surface. Above the channels and spanning them are laid a series of perforated or slotted tiles through which the sewage effluent passes to the channels and thence to the principal outlets. The arrangement of a floor sys-

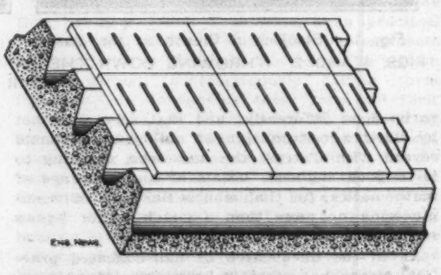

Fig. 2a. False Floor System in Percolating Filters, Built in 1909 at Baltimore, Md.

tem of this type at Hanley, England, is shown in Fig. 2. Another floor system of this general type but having the channels very near together and differing slightly in other details is under construction at Baltimore (Fig. 2A). At this plant the channel pipes are omitted and a conduit of somewhat similar cross-section is formed in the concrete floor, as has also been done at some English plants. Spanning the conduits is placed a flooring of slotted terra cotta slabs, 10 × 20 ins., forming a smooth upper surface. The slits in the tiling are to be ½-in. wide and 6 ins. long, spaced 3½ ins. apart, the open space thus formed in the false floor system, through which the effluent is to pass and the aeration to be effected, being about 9% of the total floor area.

Perforated or slotted terra cotta slabs supported upon three or more legs, have been used in England. The slabs are placed on a smooth, concrete floor and with proper design and construction the resultant false flooring should be efficient. Trouble has occurred in breakage with this system, owing principally to the occurrence of an uneven bearing of the legs upon the concrete floor. This condition could be entirely overcome by placing the false floor units in final position after the surface screeding and before the hard setting of the concrete, as was specified in

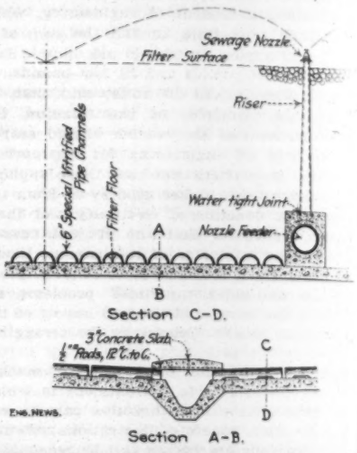

Fig. 3. False Flooring for Percolating Filters, Similar to the One Used at Columbus, Ohio.

laying the channel floor system at Columbus, O., Fig. 3.

The special forms of terra cotta have also been used abroad and some filters have even been constructed with a drainage system no more elaborate than a layer of cobble stones or other coarse matter.

Among the undesirable features frequently found in the false floor systems built up of channel pipes and various forms of terra cotta tiling are the following:

(1) The absence of a continuous false flooring over the entire filter floor surface.

(2) The necessity for the effluent to pass laterally, for a considerable distance, through the filter medium to reach effluent drains.

(3) The necessity for the effluent to change its direction of flow in passing through the false floor units.

(4) The relatively small open area through the false flooring for the passage of effluent and air currents.

Inefficiency in the first three tends to cause a deposition of suspended matters, carried by the effluent, within the filtering material, and this deposited matter cannot be easily removed therefrom by flushing or otherwise when the structural details necessitate its lateral transportation, through the interstices, to the effluent drains, while inefficiency in the fourth offers increased opportunity for the clogging of these passageways through deposited matter, and bacterial and fungoid growths fostered by a lack of air currents.

The ideal false floor and aeration system for a percolating filter would seem to be one that offers a maximum of free passageways, as to both size and percentage of the total area; that permits a direct downward course for the percolating sewage and flushing waters, without the necessity for any greater lateral movement, in reaching the true flooring, than is required to pass an average sized particle of the filter material; that possesses large and unobstructed air passages along the effluent drains and between the false and true flooring; that permits a positive and controlable movement in the interstitial air, in either an upward or a downward direction as desired, without the necessity of operating and maintaining such mechanical devices as blowers to produce the interchange; that presents the least opportunity for an improper deposition of suspended matter either within the

filter material or along the effluent course; that affords complete facility for flushing every portion of the filter material, the true flooring, and the effluent drains; and that obtains the maximum effect of these practical advantages with the greatest simplicity of construction and at the most economical cost.

During the studies preparatory to the construction of percolating filters at Waterbury, the design of the false floor and aeration system, herein described, was developed.

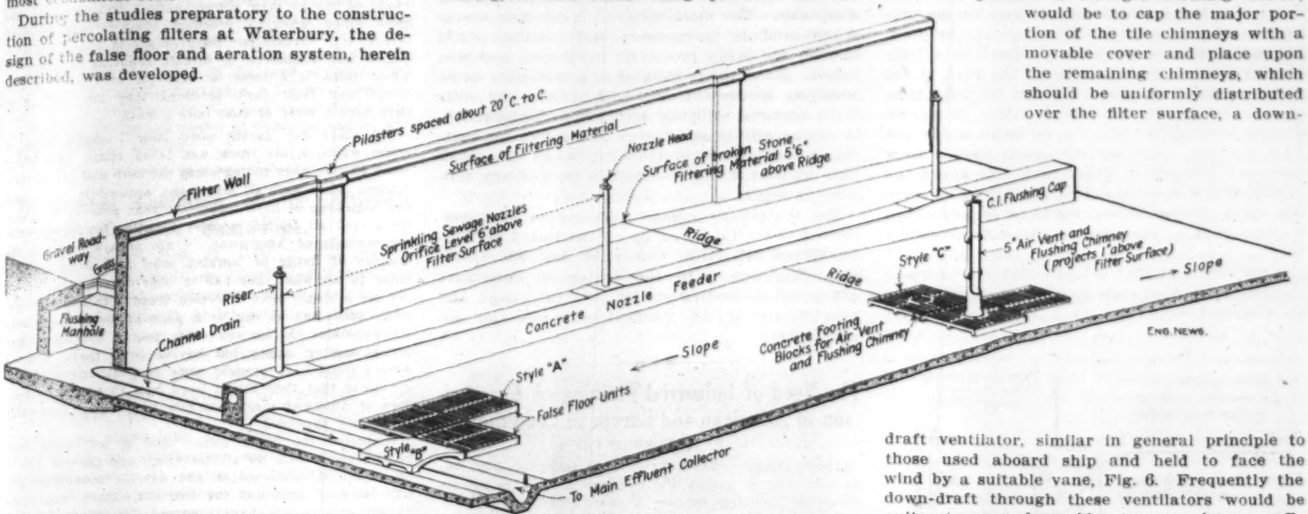

FIG. 4. TYPICAL CONSTRUCTION OF PERCOLATING SEWAGE FILTERS WITH GRID UNITS.

The false floor units are of reinforced concrete, 32½ ins. sq. and of two general types: a grid section and an arch section. Two forms of the grid section are provided (Fig. 4), styles A and C, and one form of arch section, style B. The arch type is used to span the effluent channels and provides abundantly for the passage of air currents longitudinally along the effluent channels and also transversely beneath the false flooring. Style A grid unit is used over the main body of the floor and therefore to a greater extent than either of the other styles, and is placed on the main slopes of the true filter floor between the effluent channels and the ridges. Style C grid unit is similar to style A, but has in addition, at its center, a circular opening and a rebate of suitable size, to receive the hub end of a 5-in. vitrified sewer pipe. This rebate forms the base of a pipe chimney designed to extend above the filter surface. The style C units are laid symmetrically over the line of ridges, which form parallel lines about 50 ft. apart. The general arrangement of floor slopes, false floor units, and aeration and flushing chimneys is indicated in Fig. 4. A longitudinal section through the flooring is shown in Fig. 5, and a transverse section in Fig. 6.

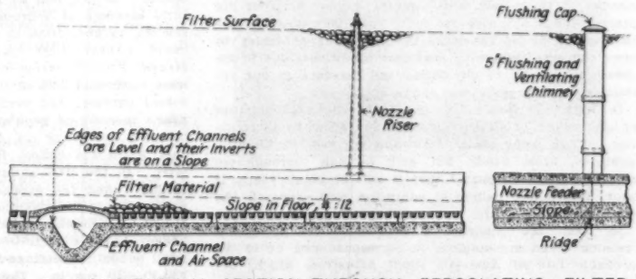

FIG. 5. LONGITUDINAL SECTION THROUGH PERCOLATING FILTER (SHOWING TYPE B. FALSE FLOORING OF FIG. 4).

It will be noticed that more than one-fourth of the entire grid area is in open space; that the formation of the units permits the vertical descent of the effluent, the solid matters desquamating from the filter material and any flushing waters applied at the surface; that no greater lateral movement is required to pass the false flooring than is necessary to pass an average-sized particle within the filter; that large, continuous, and unobstructed air passages exist beneath every part of the filter; that perfect facility is given to the vertical passage of air currents through the floor system; that solid matters reaching the smooth true flooring and falling in transportation to the effluent channels may be successfully flushed at will to said channels, and that every part of the true flooring is within the control of such flushing.

The true floor of a filter consists of a series of smooth slopes with level, parallel ridges spaced 50 ft. apart. Midway between each pair of ridges is an ample effluent-collecting channel having level lips and an invert sloping toward the main effluent outlet. After the screeding and troweling of a portion of the flooring and before its complete hardening the floor units should be laid and lightly tamped to a perfect bearing, arched slabs being placed over the effluent channels and the grid units at right angles thereto and up the floor slope. At the summit of the slopes, that is, vertically over the ridges, there is placed at the end of each line of grid units one of style C arranged for the reception of a 5-in. vitrified pipe chimney to be ultimately used for aeration and flushing purposes. Within the body of each filter a cast-iron pressure main is provided having suitable hose connections thereto. At such intervals as may be necessary the flushing cap is removed from the top of each of these chimneys, which normally projects about an inch above the filter surface, and the hose nozzle and stream is thrust into the opening. The flushing water descends in considerable volume to the true floor, where it meets the ridge which divides the flow into two parts, each part coursing down the slope beneath a single line of floor units with such strength as to dislodge deposited matters and to carry all before it to the effluent channel. Thus each chimney controls two lines of floor units, each 50 ft. long, or about 275 sq. ft. of filter floor surface.

The tile chimneys can also be variously used in promoting aeration beneath the false flooring and within the filter mass. One practicable method, available for a filter enclosed upon the sides, would be to air-seal the effluent outlets and all other openings through which currents are not desired and then cap each chimney with a non-moving ventilating cowl so arranged that the wind over the exterior surface of the filter would cause an upward draft in the ventilating chimneys and a compensating down-draft through the filtering medium. Another method, one that permits a stronger aerating action, would be to cap the major portion of the tile chimneys with a movable cover and place upon the remaining chimneys, which should be uniformly distributed over the filter surface, a down-draft ventilator, similar in general principle to those used aboard ship and held to face the wind by a suitable vane, Fig. 6. Frequently the down-draft through these ventilators would be quite strong and would set up a plenum sufficient to establish and maintain active interstitial air currents throughout the mass of filtering material.

The strength of these air currents may be readily controlled by suitable air checks, so that during the warm season a rapid interchange of air may be permitted, while during freezing weather the efficiency of the aeration system would need to be greatly restricted, or the whole action shut off, by reason of the marked effect of a low temperature upon the activity of bacterial life.

Cowls for the up-draft aeration method may be of cast iron, of low cost, without any moving parts and made very durable, while those used in down-draft method may be made of any desirable metal, hung on a low-friction pivot-bearing or otherwise, and the open mouth protected against the entrance of wind blown sewage spray, or debris, by a splash screen.

The structural details of a rotable down-draft aeration cowl suitable for service upon percolating filters are subject to great variation. That it should be simple, durable and relatively inexpensive is evident. A suggested design for such a cowl is presented in Fig. 7. The body of the hood is made of a non-corrosive sheet metal having strength and rigidity and offering little temptation to junk collectors. Some of the "ferro-bronzes," so-called, or a copper-nickel-iron alloy such as can now be procured at a price equivalent to rolled copper are suitable. Metal of this latter type has been locally tested and found very resistant to corrosion and apparently well suited for sewage work. The base consists of a short cast iron pipe having a wide flange. When in place this piece is vertically above and fitted over the top of an aerating chimney with the flange embedded within the filter material

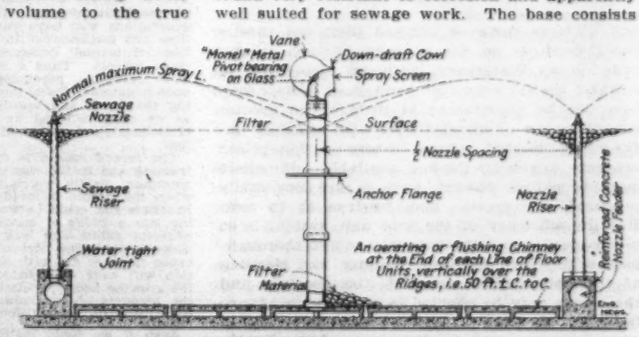
Vane
"Monel" Metal Pivot bearing on Glass
Down-draft Cowl
Spray Screen
Normal maximum Spray L.
Sewage Nozzle
Filter Surface
½ Nozzle Spacing
Sewage Riser
Anchor Flange
Nozzle Riser
Reinforced Concrete Nozzle Feeder
An aerating or flushing Chimney at the End of each Line of Floor Units, vertically over the Ridges, i.e. 50 ft. ± C. to C.
Water tight Joint
Filter Material
ENG. NEWS.

FIG. 6. CROSS-SECTION THROUGH PERCOLATING FILTER. (SEE ALSO FIG. 4.)

sufficiently deep to be secure against overturning under wind pressure. A vertical shaft, for the support of the hood top, arises from a central hub cast in the pipe and having at its top a non-corrosive pivot bearing and collar. The pivot bearing works upon a plate glass jewel and permits great freedom in response to the wind. The collar is adjusted within a brass cap for the prevention of a possible dislodgement of the hood. Lateral rigidity is given to the hood by a ball-bearing journal working against the base of the vertical supporting shaft. Within the base pipe, at a point below the rotable hood, is an air damper arranged to effect a variation in the net area, through which air may pass, from a fully open to a completely closed port. To guard the mouth of the hood against the entrance of sewage spray during strong winds, a splash screen so formed as to intercept the flying drops should be provided.

It may seem at first thought that a reinforced-concrete false floor system made up of grid units as described would be much more costly than

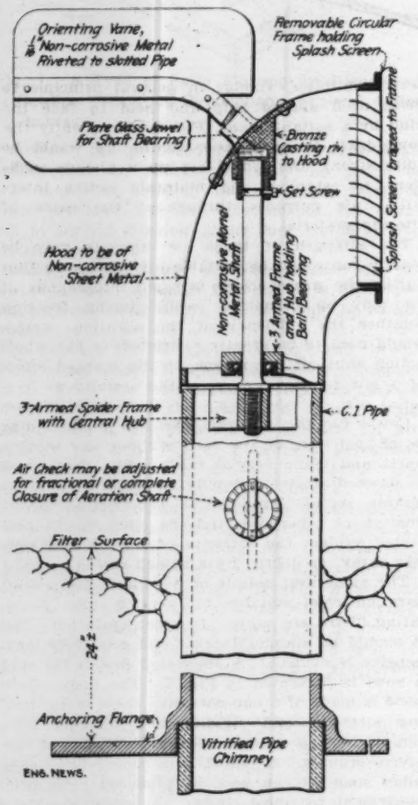
Orienting Vane, Non-corrosive Metal Riveted to slotted Pipe
Removable Circular Frame holding Splash Screen
Plate Glass Jewel for Shaft Bearing
Bronze Casting riv. to Hood
Set Screw
Splash Screen brazed to Frame
Hood to be of Non-corrosive Sheet Metal
Non-corrosive Monel Metal Shaft
3 Armed Frame and Hub holding Ball-Bearing
3-Armed Spider Frame with Central Hub
C.I Pipe
Air Check may be adjusted for fractional or complete Closure of Aeration Shaft
Filter Surface
24"
Anchoring Flange
Vitrified Pipe Chimney
ENG. NEWS.

Fig. 7. Down-Draft Aerating Cowl for Percolating Sewage Filters.

one of terra cotta or vitrified tiles, but this is not necessarily so, for on work of such magnitude as at Waterbury, with an abundance of suitable glacial gravel at hand, such a floor system can be constructed at little or no greater cost than one of vitrified tiles. On small or unfavorably located plants, where a low-priced concrete aggregate is not available and where suitably skilled cement workers are not easily procured, the reverse may be true as to cost. But the efficiency of the grid unit system is so much greater, and the convenience and thoroughness with which aeration, flushing, and cleaning of the entire filter material, the flooring, and the drains may be effected is of so much advantage, as to warrant, perhaps, its adoption in certain cases even in the face of a slightly greater initial cost.

Sufficient tests were made in the casting of individual units to serve as a proper basis for estimates as to the cost of such work, and the results of these local tests were proved by two additional independent estimates of cost prepared by competent experts after a careful consideration.

Several methods are possible for casting the units, but that of using a fine loamy sand, prepared to resist the entrance of the thin concrete mixture into its pores, by the admixture of kerosene or other thin oily fluid, seems particularly adaptable. The mold material is common everywhere and is inexpensive and castings made therein are easily protected, moistened, and seasoned. Breakage is reduced to a minimum as no handling is required until such time as the units have acquired sufficient strength to withstand it. A comparatively small area will suffice for casting a large number of the units, as the pieces may be poured and seasoned in tiers of any convenient depth.

The Waterbury sewage studies have been conducted under the direction of the Board of Public Works, Mr. R. A. Cairns, M. Am. Soc. C. E., City Engineer, with the writer in immediate charge of the testing station, and the design and construction of the purification works and appurtenances.

The Need of Industrial Training: A Comparison of American and European Conditions.*

By P. KREUZPOINTNER.†

I take pleasure in answering your query of Nov. 10, as to whether or not the United States is likely to lose its industrial standing because of our unpreparedness for training those who are to enter industrial life.

I was an apprentice in Munich's industrial schools from 1856 to 1861 and as I have followed the development of European systems of industrial training ever since and the drift of their industries, being a member of two European technical societies, I can best answer your question first in the words of prominent foreign engineers who visited this country, studied its industrial conditions, and gave me their personal opinions in conversation here in Altoona. The consensus of their opinion seems to be that, unless we adopt a system of thoroughly training our industrial workers in a manner similar to their own, this country cannot keep up its present industrial pace for more than 20 years because that education of the mass of the people necessary to meet the ever tightening economic conditions, due to increase in density of population and decrease in our resources is inadequate and inefficient.

In 1904, the German Government sent a commission of six picked educators to study our educational facilities. They went about very quietly, avoided dinners, publicity, brass bands, but with German thoroughness investigated and reported that it will be many years, if ever, before our industrial education will approach the effectiveness of theirs.

In 1903, the Austrian superintendent of industrial training asked my opinion, in correspondence, as to the probable fate of Austria's small industries which, because of the lack of resources to support extensive concentrated manufacturing, are the country's mainstay. These small industries are being hard pressed by the flooding of Austrian cities with American goods. I told him that if Austria could keep its small industries above water for 20 years, they would not be much troubled by American competition for two reasons:

First, that so little attention was paid in this country to technical education in our schools, that when this necessity for technical and scientific training is grasped the psychological condition of the present generation will be too far advanced. It will not be receptive for philosophical thinking. The mind of present and passing generations will have run exclusively along mechanical lines and mathematics in the higher branches, and along lines of manual dexterity in our manual training and trade schools. Thus a new generation will have to be made receptive, psychologically, to absorb and develop, upon a national scale, the mental power of readily grasping the depth and breadth of technical education, such as we need to bring us approximately to the standard of industrial education of our foremost foreign competitors.

The second reason is in the absence of this technical training and in the wasteful habits of the people and its workmen, habits which are the inheritance of a time when the people believed that our resources were inexhaustible and could be wasted with impunity. Then saving was a badge of meanness and niggardliness. These wasteful habits and lack of technical knowledge necessary to make the best use of our remaining resources, cause them to diminish so rapidly that the next generation will have to exercise economy to keep enough for the growing home population. Little will be left to throw the products of our industries upon the markets of our competitors in competition with their home industries.

Even if we could instill into the masses, within one year, the desire for technical education and the receptiveness of mind to absorb technical teaching and if we could, with our usual energy, apply the knowledge, we would still be at a great disadvantage because our foreign competitors are used to pinched conditions and can tighten their belts still more, while our mechanics do not know as yet what a tight belt means.

I have spoken with mechanics who told me that they would cause a revolution if they could not have two kinds of pie in their dinner pails. This indicates the spirit which, when our economic pressure becomes more severe, will increase our disadvantage in competing with people and mechanics of foreign countries, millions of whom think it a treat to have pie at Christmas and Easter and feast days, or think they are well off if they have a scrap of meat once a week.

The other day during noon hour I passed along a street where a car track was being relaid, and where some 40 men were sitting along the curb and eating their dinner. They were all Americans, apparently, since with the beginning of hard times last year some corporations discharged all Italian laborers to make temporary room for unemployed Americans. I am always studying the manner of living of working men and walked slowly along to see what they had in their dinner pails. I did not see a single piece of brown bread with any one, and while some had an egg or a piece of meat, there were many pickles, jellies and other poorly nourishing materials costing money but having little food value. I wish I could have brought some domestic-science teachers along that they might learn how to teach the children of American mechanics how to get good food value for money expended.

Whenever the pinch comes, and it will come soon enough at the rate we are traveling, and the belt has to be tightened, the cheaper and equally nourishing diet will come of itself and the domestic-science department of our schools will have prepared the ground for new conditions by training in that skill and knowledge which a turn to changed conditions of life makes possible without great hardship. You see the interdependence of industrial education for the sexes if we want to counteract the forces which now tend to make us lose our industrial standing in competition with our foreign rivals.

To raise money for the establishment of a comprehensive system of public trade and industrial schools should not be difficult for us if poor Belgium, Germany and Austria can do it. The city of Munich, 520,000 inhabitants, supports 48 trade schools and 12 manual training schools. If we had as many industrial schools as the little kingdom of Würtemberg, we ought to have 30,000 schools, in proportion to population. Pennsylvania alone ought to have 1,000. A friend on the School Board of Hagen, Prussia, wrote me that for the year 1908 they were to expend 33% of the total taxation of the city for school purposes and even that does not provide for this year's increase of population.

If we would ask an American community to expend that much the School Board would be denounced bitterly. In the 1907 annual school report for the city of Hagen I find the expenditure per pupil of the "Realgymnasium," the "Gymnasium" and the "Unterklassen" $88.62—722 pupils. The expenditure per pupil in the "Oberrealschule" $81.67—496 pupils. The expenditure per pupil in the "Lehrerinen-Seminar und Seminarvorschule," $20.30—670 pupils. The expenditure per pupil in the "Hoehere Maschienenbauschule," including evening and Sunday classes, $92.20—240 pupils. The expenditure per pupil in the elementary schools $18.50—14,379 pupils. I do not know what the city's budget was for 1907, but for 1908 it was three million marks, one mark equaling 24.8 cts., and my friend wrote me that there were more than one million marks of that three million appropriated for schools. There were 600 girls in the domestic science of "Haushaltungsschule" and all the boys, of course, were obliged to go to some kind of industrial school until 17 years of age. See why the American consul at Stuttgart, Würtemberg, complains that less and less is imported from the United States and more and more is exported to the United States.

But even if we could command the use of $500,000,000 and could train 100,000 teachers in a week, we would still be handicapped by the retarding traditions of our schools, especially the unfriendliness of the high school toward industrial education in it. We would be handicapped by the lack of cooperative spirit which makes the school people, the industrial people, the professional people, the lodge, the society, club and church people, the labor union and nonlabor union people, the American, Irish, Scotch, German, Englishman, each go his own way without harmony of purpose and unity of action. In Germany and Belgium these astonishing sacrifices for education are made possible by the unrestrained cooperation of all social forces without reserve and distinction. When it comes to education, the capitalist and the laborer, the monarchist and the socialist work in perfect harmony.

Our high tariff is also a disturbing factor inasmuch as it creates a sense of security from outside interference in the great mass of industrial workers. Where a large concern could easily learn economic ways of production by sending some bright man abroad who, without dishonesty of any kind, could learn better ways of

*Extracts from a letter to the Superintendent of Schools of Seattle, Wash., published in the "American Machinist," May 20.

†Chairman of the Committee on Industrial Education of the American Foundrymen's Association, Testing Laboratories, P. R. R., Altoona, Pa.

doing things, months and years were spent and material was wasted to learn the same thing, painfully and laboriously by experimentation.

Summing up, then, the various points in answer to your question whether the United States is likely to lose its industrial standing because of the absence of systematic training of those who enter industrial life, the answer must be in the affirmative as long as we make no concerted and systematic effort as a nation to supply that training. We must adjust and adapt our educational system to those new social and economic conditions where the study of the laws of nature, the application of scientific knowledge, a sincere cooperative spirit, a high sense of civic duty and responsibility must make up for diminished wealth of resources and circumscribed individual activity.

The Present Condition of the Attleboro Concrete Stand-Pipe.

In our issue of Feb. 21, 1907, p. 212, we devoted several pages to an illustrated description of the design and construction of the reinforced-concrete stand-pipe at Attleboro, Mass., then just completed. At that time there had been no opportunity to observe the structure in service or to judge of the availability of reinforced concrete under such severe conditions of pressure. Since then we have received a number of inquiries regarding the stand-pipe as well as a few letters condemning its appearance and discrediting its watertightness. In order to satisfy ourselves and to inform the profession regarding so important a development in concrete, a member of the editorial staff of this journal recently made a visit to Attleboro and inspected the structure. The results of that inspection are here recorded.

Briefly, the Attleboro stand-pipe is a reinforced-concrete cylindrical tank, of 1,500,000 gals. capacity. It is 50 ft. in diameter, and 102 ft high to the maximum water line, with a plain concrete exterior surface, surmounted with an ornamental cornice and a tile roof. The walls are 18 ins. thick at the bottom and 8 ins. at the top, reinforced with vertical 4-in. channel irons, holding two rows of circumferential round bars varying from 1½ ins. at the bottom to 1⅛ ins. at the top, and with vertical spacing from 4 to 8 ins., respectively.

No included waterproofing compound was used in the concrete walls, but great effort was made to form a hard, dense, well-tamped mixture. After the completion of the walls, several coats of sand-cement mortar were applied to the inner surface and finally a coating, in accordance with the "Sylvester process," of soap and alum wash, was applied. This latter was completed by December, 1906. The stand-pipe was put into service immediately thereafter, and, according to the town authorities, no subsequent attempt at waterproofing has been made.

According to Mr. Geo. H. Snell, superintendent of the Water Department of Attleboro, the standpipe is now regularly filled to its limit every day and drawn down to about the 25-ft. level every night, so that at least for a portion of the 24 hours the tank is withstanding the maximum pressure for which it was designed. From the same authority we also learn that so far as could be determined there has been no freezing inside the tank in any of the three winters in which it has been used.

The visit to the stand-pipe by the member of our staff was made on July 29, one of the hottest days of the summer, at about 10 a. m. when the temperature was well above 90° F. At that time of the morning the water in the tank is near its lowest level, but is filling slowly.

One of the main claims of the advocates of the reinforced-concrete stand-pipe is its artistic merit. This claim is hardly substantiated by the Attleboro structure. From the train coming into town, it looms up on its hill as a smooth, straight cylinder of fair proportions, quite as graceful as could be expected for so utilitarian a purpose, but a nearer view, revealing the texture of the surface, is far from pleasing. In the first place the forms, which were of uniform height, have left circumferential horizontal marks 7½ ft. apart, which from a distance resemble the rivet lines of a plate-steel tank, so that insofar as surface appearance goes a steel tank painted concrete-grey would be equally as desirable. In addition, the whole surface is marked with vertical streaks of efflorescence, as a rule starting from a form mark and tailing down. These dirty white narrow splotches on the grey surface destroy any desirable qualities a concrete finish might have. However, it is not usually the purpose of a water tower or stand-pipe to beautify its surroundings, nor is there often any effort made to design a decorative or monumental structure, so the Attleboro stand-pipe is equally as good in this respect as any other. And from a distant view, such as from the town itself, it is probably more effective than the average steel stand-pipe.

There are three minor leaks and an extensive area of efflorescence now showing on the stand-pipe, all in the lowest 8 ft., and mostly immediately above the bottom curbing. The efflorescence consists mainly of six streaks, starting some 8 ft. above the ground and tailing down to the top of the curbing. Each of these streaks is 8 to 10 ins. wide and is made up of a ½-in. thick-

A Near View of a Portion of the Lower Part of the Attleboro Stand-pipe.

(The dark spot in the lower left is the leak called L_2 in the text; the small dark spot at the extreme right just above the curb is L_3. Note horizontal form marks and efflorescent splotches, especially just above the curb. About 10 ft. in width of the stand-pipe is here shown.)

ness of a hard stalactite-like salt. One one side of this group of streaks there is a solid sheet of this same material, extending some 12 ft. around the tank, 12 or 15 ins. above the curbing. In no place is there any moisture nor does there seem to be any evidences that there ever was a material leakage here, though there probably has been a porous percolation which leaked out the salt of efflorescence. At other places there are efflorescent splotches, but they are hardly more than discolorations and do not show the thick salty incrustation evident at this one location mentioned.

The three leaks will be termed L_1, L_2 and L_3. At L_1 there is an old leak evident about 7 ft. from the ground; no water is now apparent but a decided efflorescent streak shows and there is a discoloration where the water trickled out. Below this old leak, which must have closed of its own accord, there is now the leak called here L_2. This is an area about 8 ins. long, and 4 ins. high, from which water is now percolating and from which also the outer surface of the concrete to a depth of perhaps ¼-in. has scaled off. The amount of water coming from the leak is very small, and so distributed that the whole area is wet although no one spot seems to be leaking. There is, however, a small amount of water trickling from the bottom of the patch and trailing over the curbing onto the sidewalk around the tank, where there is a damp spot. Leak L_3 is farther around the tank, also just above the curbing. It is about 12 x 12 ins. in area and displays the same characteristics as L_1, except that there does not seem to be quite as much water coming through. L_3 is very near L_2 and is a mere pin-hole leak through which there is the smallest amount of percolation. In the accompanying half-tone is shown a near view of the stand-pipe at the location of L_3. The efflorescent splotches are well shown.

These three were the only evidences of leakage on the tank on July 29, and no one of the three was then passing any appreciable amount of water. It would be difficult to estimate the amount of leakage, except to say that in no place was there the slightest evidence of spurting from a defined leak. Rather was it in each case an extended area of heavy moisture. The peeling of the surface at L_1 and L_2, extended only through the outer skin and the exposed face seemed quite as solid as the undisturbed finished face, though of a somewhat rougher texture.

Summarizing, it may be said that after 2½ years of constant use the stand-pipe shows three very minor leaks, the danger from which is a possible future deterioration rather than a sudden failure of the wall structure, and a decidedly disfiguring surface efflorescence, which is an esthetic and not a structural defect. These observations were made on a mid-summer's day, when the conditions were most favorable to the stand-pipe, but it had passed through three winters so that any surface damage to be expected from freezing and thawing of percolating water must have already occurred.

A Supplementary Report on the Proposed Subway System for Street Cars and Elevated Railway Trains in Chicago.

The proposed subway system for the business district of the city of Chicago was dealt with at some length in our issue of June 3, 1909, the system in question being that advocated in a report made to the Commissioner of Public Works by a special board of engineers organized to investigate this matter. In our article reference was made to a supplementary report, then in preparation, dealing with the traffic conditions and means of handling the traffic until the year 1950, when the population is estimated to amount to 6,000,000. This report presents an extended and interesting study of the distribution and development of the traffic, and the development of the subway system to provide for the increasing demands upon its capacity. The work on this supplementary report has been done entirely by Mr. R. C. St. John, one of the engineers of the board, acting under the general supervision of Mr. John Ericson, City Engineer. The report has not been printed, but we have been furnished with an advance copy by the courtesy of Mr. St. John and Mr. Ericson. Some features of the report are commented upon in our editorial columns.

It may be explained that the general purpose of the subway system is to relieve the present congestion of traffic in the business district by removing the street cars and the obstructive elevated railway structures from the crowded streets, thus facilitating both vehicular and rapid-transit traffic. It is not intended, therefore, to form an independent rapid-transit system, like the New York subway.

In regard to the growth of population and traffic it appears that in 1910, with a population of 2,700,000, the total traffic will be 607,671,000 rides, or about 230 rides per capita. In 1940, with a population of 5,500,000, the total number of rides will be (it is estimated) 2,210,200,000, or about 404 rides per capita. This includes surface, elevated and subway traffic. The congestion of traffic has been investigated also, and it appears that at the present time the average speed of the surface cars is 9.21 ft. per sec. in the district within the proposed subway zone, 11.48 ft. per sec. within the first mile beyond this zone, and 16.24 ft. per sec. within the second mile beyond the subway zone. These speeds are equivalent to 6.28, 7.8, and 11.07 mi. per hr. On this point the report states:

The density of traffic congestion is constantly increasing and extending over longer periods both morning and evening. The result is that the time required to go to and from work is increasing, which consequently lengthens the working day.

Not only is the rapid growth of the city leading to this undesirable result, but as the congestion in the streets in the business district increases the interruption to surface traffic is leading to a smaller capacity for carrying passengers on surface lines. The present actual maximum traffic per hour on surface lines entering the business district is but 62% of what it was estimated to be seven years ago, notwithstanding that extensive improvements have since been made and that the total annual traffic of the surface lines has increased 30%.

The surface congestion within the subway zone and the insufficient capacity of the elevated loop so retard the movement of the surface cars and elevated trains that no matter how large may be the number of cars and trains the traffic cannot be handled expeditiously. In fact, if fewer cars were placed in service by the surface lines, or at least if the headway of the cars on the main surface lines was increased (particularly the headway of cars entering the subway zone or business district to handle the outbound maximum traffic), better results would be obtained.

The capacity of the elevated lines, as it relates to traffic into and out of the business district, is limited to the capacity of the elevated loop. The capacity of the loop has been reached, and can be increased only slightly by physical changes and revised methods of operation. Stub terminals, while adding to the capacity of the elevated lines [outside of the loop.—Ed.] serve only those patrons whose destinations are near these terminals.

The existing main lines of transportation have reached their ultimate practical capacity for carrying passengers. An increase of 100% in the carrying capacity of existing loop transportation facilities would still leave a period of congestion in the morning and evening traffic.

In order to obtain exact figures as to the traffic, careful observations were made (by trained observers) during a 24-hour period, covering the numbers of passengers carried on the various lines, and keeping separate records of the inbound and outbound traffic. The results checked very closely with records of fares kept by some of the lines. These observations were made on Feb. 19, 1909, and from the numerous tables in the report we have compiled the summary given in Table I. Of the total number of passengers carried, the numbers standing (including both directions of travel) were as follows: (A) Elevated trains; total, 48,371; in maximum hour, 19,664; (B) surface cars; total, 88,490; in maximum hour, 35,526. The period of heavy inbound traffic on the elevated railways was from 6.30 to 9.45 a. m., and its maximum ¼-hour period was from 7.45 to 8 a. m.; for the surface cars, the periods were 7 to 9 a. m. and 7.45 to 8 a. m. The period of heavy outbound traffic for the elevated railways was from 4 to 7 p. m., with a maximum ¼-hour period from 5.45 to 6 p. m.; for the surface cars these periods were 5 to 6.30 p. m. and 5.45 to 6 p. m.

The handling of the traffic of the rush periods is the serious problem. The report states that in most cities the traffic of the heaviest hour is generally 10% of the total traffic for the day. The congestion in Chicago is much greater. On the elevated railways, inbound and outbound, the traffic of the heaviest hour is 33% and 36% of the total inbound and outbound traffic, respectively. On the surface lines the traffic of the heaviest hour is 20% and 25% for the total inbound and outbound traffic, respectively. The high percentage carried during the heavy-traffic hours in Chicago, in comparison with that of other cities, emphasizes the greater magnitude of the transportation problem.

It is believed that the subway terminals at the boundaries of the subway zone should be used not only as outlets, but also as terminals for the storage of the extra equipment that handles the traffic of the rush period. Thus the extra cars and trains that bring the inbound traffic in the morning, would be held at these terminals (after passing through the subway) ready for the evening outbound traffic, instead of returning empty (or practically so) to the outlying terminals and being brought back empty just before the evening rush hour.

In the laying out of the system of subways there are two distinct fundamental arrangements, which may be utilized separately or in combination: (1) the loop system, by which cars from either side of the city loop around a certain part of the business district and return in the same direction; (2) the through system, by which cars pass through the business district, so as to give through routes (without change of car) from one side of the city to another. The report shows that the subway system should provide for through routing. A passenger from the north side should be able to ride without transfer as far north as Chicago Ave. and south to 12th St.; a passenger from the north should be able to ride in the same way as far as 12th St. on the south or Halsted St. on the west; and a passenger from the south side should be able to ride in the same way to Chicago Ave. or Halsted St. The subways through which these passengers travel, however, should pass through the main part of the business district. There should be no grade crossings. The report states that single-deck subways may be constructed within the congested area with capacity sufficiently large to meet the traffic demands of all elevated and surface lines, making it possible to eliminate all trains and cars from the elevated railways and the street surface.

A number of alternative plans are suggested. We illustrate herewith the two general plans as proposed by Mr. St. John. The first of these, Fig. 1, provides for through routes only, with no loops, and is designed to accommodate the traffic for several years; the traffic capacity per hour would be as follows: from elevated lines, 408,000; surface lines, 132,900; total, 540,900 passengers. Loops would be built as required to increase the capacity, and Fig. 2 shows the complete system designed to handle the traffic of 1950. The traffic capacity per hour would be as follows: from elevated lines, 748,000; from surface lines, 310,000; total, 1,058,000 passengers. The length of the period for which the capacity would suffice would depend upon whether all passengers must be given seats or whether standing room may be utilized. The figures for the two plans shown are summarized in Table II.

It will be noted in Fig. 2 that the north and south through route on Market St. makes a diverging loop through the business district. The object of this is to carry passengers to and from the center of that district. It is suggested, however, that this particular loop might be eliminated if desired, and the capacity increased by running this subway directly across the city on the line of Market St.

The plan as proposed in the report, and described above, has been criticised as having an excessive "dead mileage" for the equipment, meaning travel which does not produce revenue. Mr. St. John points out that his through-route single-deck plan (Fig. 1) has an earning capacity of 13,020 passengers per hour per mile of track, as against 11,035 passengers for the double-deck plan suggested by Mr. B. J. Arnold in 1902, which latter plan did not provide for the traffic of the elevated lines. As to the question of "dead mileage" Mr. St. John states:

> The minimum "dead mileage" would be the movement of equipment into and out of the business area by the shortest possible route to collect traffic or passengers. In other words, the least "dead mileage" for the equipment is the greatest live mileage for the public on foot, a sacrifice of the public's convenience for the benefit of the operating companies by compelling the public to walk excessive distances to take cars and trains.
>
> The business area, where congestion should be relieved and the public be given an opportunity to get out of or into quickly, is too extensive to compel the public to walk an excessive distance to the different stations for the purpose of eliminating "dead mileage" entirely. There is a medium "dead mileage," however, and it was to this end that the plans as prepared by the Bureau of Engineering were designed.
>
> The more "dead mileage" the less revenue per mile, or the greater the number of passengers per mile the less "dead mileage." That is, the track that passes into the business district and out again that will permit cars or trains to carry the greatest average number of passengers per hour for each mile of its length has the least "dead mileage."

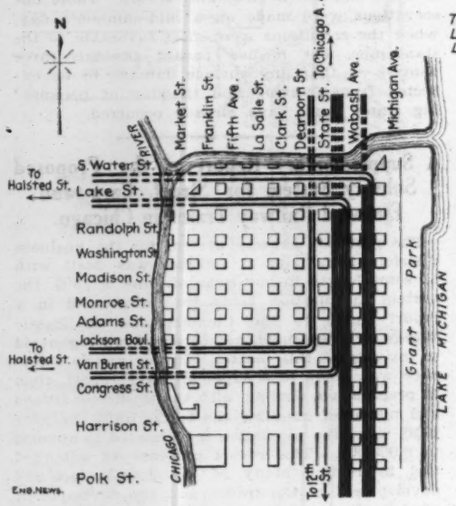

Fig. 1. First Part of System, with Through Routes Only.

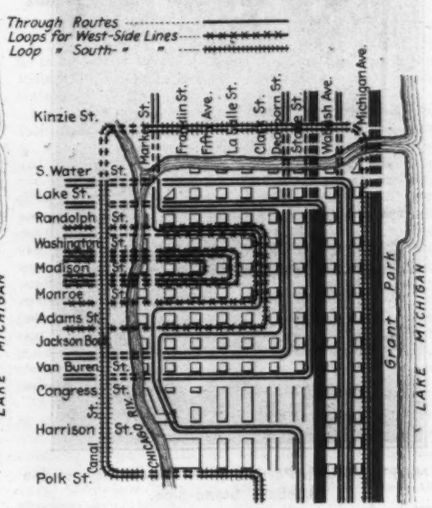

Fig. 2. Completed System (for 1950), with Through Routes and Loops.

PLANS OF PROPOSED ARRANGEMENTS OF SUBWAYS IN THE BUSINESS DISTRICT OF CHICAGO. (PLANS NOT DRAWN TO SCALE.)

TABLE I.—ELEVATED RAILWAY AND STREET CAR TRAFFIC OF THE BUSINESS DISTRICT OF CHICAGO: FEB. 19, 1909.

(From observations made at the boundaries of the district.)

	Elevated railways		Surface cars	
	Inbound.	Outbound.	Inbound.	Outbound.
No. of passengers:				
24 hours...	188,042	174,890	244,201	280,794
Max. hour..	62,077	62,784	50,074	60,919
Max. ¼-hour	19,446	20,538	14,870	19,443
No. elevated trains & surface cars:	Trains		Cars	
24 hours...	2,187	2,201	12,015	12,152
Max. hour...	215	194	909	959
Average headway (seconds):				
Max. hour...	64 to 120	78 to 124	28 to 62	26 to 48
Max. ¼-hour.	60 to 82	78 to 100	26 to 69	28 to 43

TABLE II.—TRAFFIC CAPACITY OF PROPOSED SUBWAY SYSTEM AT CHICAGO.

	Through routes only.	Through routes and loops (complete system).
Capacity, passengers per hour:		
Seated only.....	270,480	529,120
Seats and 50% standing room.....	405,720	793,680
Seats and 100% standing room.....	540,960	1,058,240
Year when traffic will equal capacity:		
Seats only	1918	1932
Seats and 50% standing room	1926	(after) 1950
Seats and 100% standing room...	1934	(after) 1950
Cost, including utilities..	$41,000,000	$108,000,000
Cost, exclusive of utilities.	$41,500,000	$93,000,000

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Will some one who knows explain the long and mysterious delay in the famous Peoria electrolysis suit? So long ago that many people not deeply interested in the electrolysis of water and gas mains have forgotten all about it, the Peoria Water Works Co. brought suit against the Central Railway Co. (now the Peoria Railway Co.) for relief from electrolytic damages to water mains through the return electric currents of the street railway system of Peoria. As stated elsewhere in this issue in more detail, a master in chancery took voluminous testimony in the case and after a not unreasonable time brought in a clear-cut and emphatic finding in favor of the water company. A year later, argument was heard, and then the case waited on the pleasure of the court for some five years. Two years ago the federal judge in question suggested that the case be transferred to another judge. Since then there has been movement in the case. But why that delay of five years, only to result in a transfer to another judge?

The delay and its attendant circumstances have been all the more remarkable in view of the assertion of the master or referee that the damage being wrought by electrolysis was bound to cause the ultimate destruction of the water mains. This assertion, as well as such of his other earlier findings as have just been reviewed by the master, has been borne out by the recent testimony, as may be read elsewhere in this issue.

We trust that the judge who now has the case in hand will be more expeditious than was his predecessor. Otherwise, the Peoria water mains, like the property of the wards in Jarndyce vs. Jarndyce, will all have disappeared before the litigation concerning them is ended.

A report on the street railway and rapid-transit traffic of Chicago which is noted elsewhere in this issue brings out two very important points relative to the provision of rapid-transit facilities in crowded business districts. In the first place, the great growth of street traffic and street railway traffic in Chicago, has produced such a state of congestion in the business district that the number of passengers carried per hour in this district by the street cars is actually 30% less than it was in 1902. This reduction has taken place in spite of the great improvements that have been made during that time, such as the introduction of larger and better cars and more systematic police regulation of the traffic. This condition is due to the slow movements of the cars and the continual interruptions to their movement by cross traffic at street crossings and by blockades. It is not due to any reduction in the number of passengers, as the total annual traffic of the surface lines has increased 30% since 1902. It is very evident that to put on more cars, to meet a popular demand when complaints are made as to rapid-transit facilities, may even reduce the capacity of the lines by increasing the congested state of traffic in the streets. The second point to which reference is made is the enormous percentage of the total traffic which in Chicago is concentrated in one hour of the morning and evening rush periods. The actual figures are given in the article already mentioned.

In regard to the present congestion of the street and surface car traffic in Chicago, it may be noted that this is aggravated in several cases by faulty routing of the cars, which involves excessive distance of travel and an excessive number of corners to be turned. The present long cars swinging around the corners make such a wide sweep as to block lines of traffic and necessitate very slow movement of the cars to avoid fouling other vehicles. Where two lines curve in opposite directions at one street intersection and cars approach at the same time, the car on one line must wait before taking its curve, as the sweep of the end of the car on the other line fouls the track of the first line. In at least one case the terminal loop of a surface line is so arranged with reference to the street on which the line runs, that the inbound and outbound tracks actually intersect. The checks, stoppages and slow movements in crowded streets all tend to hinder traffic movement and cause blockades. These conditions may be aggravated easily by a trolley getting off the wire or a wagon being stalled, especially if this occurs at a street corner or intersection. A material improvement over present conditions could be effected, without doubt, by a systematic revision of the routing of surface cars in the business district. It may be noted also that the curves for these long cars are necessarily so arranged as to require the cutting away of part of the sidewalk at the corner, while the body of a car on the curve projects over the sidewalk and is liable to strike pedestrians.

Public attention has been again called to the question, Is there a serious danger that the water-powers of the United States will be virtually monopolized by a huge water-power trust? The subject has been agitated for a year or so past in connection with the great movement for the conservation of the natural resources of the country. Perhaps no one man has been more earnestly impressed with the danger, and has attempted to do more to call it to public attention, than Mr. Gifford Pinchot, Chief of the United States Forest Service. At the recent Irrigation Congress at Spokane, Mr. Pinchot spoke so forcibly on the subject that his words have been repeated from end to end of the country. After declaring that the law of the land is "supreme and must be obeyed," but that strict construction of the law "necessarily favors the great interests as against the people, and in the long run cannot do otherwise," Mr. Pinchot continued:

> Wise execution of the law must consider what the law ought to accomplish for the general good. The great oppressive trusts exist because of subservient lawmakers and adroit legal constructions. Here is the central stronghold of the money power in the everlasting conflict of the few to grab, and the many to keep or win the rights they were born with. Legal technicalities seldom help the people. The people, not the law, should have the benefit of every doubt.
>
> There could be no better illustration of the eager, rapid, unwearied absorption by capital of the rights which belong to all the people than the water-power trust, not yet formed but in rapid process of formation. This statement is true, but not unchallenged. We are met at every turn by the indignant denial of the water-power interests. They tell us that there is no community of interest among them, and yet they appear year after year at these congresses by their paid attorneys, asking for your influence to help them remove the few remaining obstacles to their perpetual and complete absorption of the remaining water-powers. They tell us it has no significance that the General Electric interests are acquiring great groups of water-powers in various parts of the United States, and dominating the power market in the region of each group. And whoever dominates power, dominates all industry. Have you ever seen a few drops of oil scattered on the water spreading until they formed a continuous film, which put an end at once to all agitation of the surface. The time for us to agitate this question is now, before the separate circles of centralized control spread into the uniform, unbroken, nation-wide covering of a single gigantic trust. There will be little chance for mere agitation after that. No man at all familiar with the situation can doubt that the time for effective protest is very short. If we do not use it to protect ourselves now, we may be very sure that the trust will give hereafter small consideration to the welfare of the average citizen when in conflict with its own.

These words deserve careful consideration, both by those who do and those who do not agree with Mr. Pinchot's assertions. For, on the one hand, if there is a grave danger of a water-power trust then the country should be awakened to speedy action against it. On the other hand, if there is no such danger the fact should become plainly known as soon as possible, in order that the very considerable energy that is being devoted to water-power agitation may be directed against some of the unquestionable evils of the day.

There can be no question but that heretofore the people of the United States and of the several states have failed to properly safeguard their common rights in public property. This has not been strange in view of the lavish natural resources of this great country. But now the time has more than come when attention should be concentrated on the conservation of natural resources, not only against waste, but against diversion from their real owners, the general public, to a limited few, without adequate compensation.

Some of Mr. Pinchot's remarks at Spokane appear to have been grossly misrepresented, perhaps on the basis of fragmentary press reports. We refer particularly to allegations and discussions which have represented him as proposing to right wrongs by disregarding or setting aside the law of the land. A careful reading of all the reports of Mr. Pinchot's Spokane address which have reached us shows nothing of the sort. What he did say (see our quotation) that might have been misinterpreted or twisted by those who care more for a good newspaper story than for the truth, was that when legal rights are difficult of interpretation, "the people, not the law, should have the benefit of every doubt."

American and British cities are slow in giving attention to the science and art of town planning. The importance of the subject has been recognized and acted upon in Continental Europe for some time past, particularly in Germany. It is gaining recognition in England, although its chief practical manifestations have been in connection with new housing schemes and industrial towns. In the United States the need of giving more serious attention to town planning has also been gaining recognition, as witnessed by reports made during the last five years on the improvement of the street plan, park system and general esthetics of a number of American cities. The attention given the subject by civic and allied associations is also a further witness of the American awakening.

In May of the present year a National Town Planning Conference was held at Washington, D. C. Two weeks ago a similar conference was held in England. Elsewhere in this issue we give a report of the British Conference prepared by Mr. F. L. Ford, M. Am. Soc. C. E., City Engineer of Hartford, Conn.

The largeness of the subject of town planning is in part indicated by the number of its aspects mentioned in Mr. Ford's report of the British

Conference. A thoughtful reader of that report will be impressed with the fact that thus far only a few of the subjects treated upon at the conference have been given more than very scant attention in this country. Reflection will also convince the reader that as a rule such attention as has been given to town planning has not come from municipal authorities. That is to say, most of the reports that have been made and conferences that have been held have had their origin in citizens and citizens' associations rather than in members of any city government.

Aside from directing attention to Mr. Ford's report, and again calling attention, as we have before, to the importance of town planning, we wish at the present time only to mention one of the many lines of thought that are suggested by the papers presented at the British Conference. The one point to which we direct further attention is that the town planning needs of the future require that the righteous, but too seldom voiced and too little heeded, demands of humanity be given at least as much consideration as the insistent and powerful demands of property. The time has come when, whether in town planning or in municipal health-protective work, human comfort, health, life and morality should no longer be made secondary to property, and when our cities and states should recognize, as someone else has suggested, that their greatest wealth lies in the health and character of the whole citizen body rather than in the money value of the lands, buildings and corporate interests of a small minority.

Inasmuch as the reinforced-concrete stand-pipe at Attleboro, Mass., is the largest structure of that type ever built and as it now has been in service throughout nearly three years, its present condition, as noted on another page of this issue, ought to be indicative of some of the things to be avoided as well as to be desired in similar constructions. A stand-pipe should be safe, it should be reasonably cheap in first cost and in maintenance, and it should not be a blot on the landscape. To what extent does the Attleboro tank answer these qualifications?

So far it has been perfectly safe, though some doubt has been thrown on its future safety on account of the few leaks which have appeared. The danger in percolation through a concrete wall is two-fold; alternate freezing and thawing may cause a gradual disintegration of the wall structure or the percolating water may rust the reinforcing steel to a point of fracture under the heavy load. At Attleboro, the low temperature of three winters has not yet caused any more than a mere surface disintegration nor does the amount of leakage seem sufficient to warrant expectations of such damage in the future. On the other hand, the possibilities of interior rusting are great and apprehension regarding this danger is not lessened by the impossibility of determining the extent of the rusting. No attempt has been made to close up the leaks, partly because such repairs would necessitate the emptying of the tank for some little time, to the detriment of the water-supply system, and partly because it was thought that the gradual passing of sediment through the very small holes would finally close the leaks automatically. If this automatic stoppage does not soon occur it is probable that some other steps will be taken to make the tank absolutely tight, which, in view of the minor leakage should not be very difficult.

As far as the low cost is concerned, the engineers of the Attleboro stand-pipe have said that its cost as built was $3,000 less than that estimated for a steel stand-pipe of corresponding volume, and to date the maintenance has been practically nil, though if any extensive waterproofing has to be periodically made, the upkeep charges will be somewhat added to.

Although concrete is capable of considerable grace of line and exterior decoration, in this particular structure the simple lines of the huge cylinder are relieved only by the cornice and no effort was made to procure a pleasing surface finish. Furthermore, the development of the efflorescent streaks has detracted greatly from whatever of artistic merit the stand-pipe ever had. As this efflorescence is almost certain to form on the face of thin water-retaining concrete walls, it is almost useless to attempt a treated surface for concrete stand-pipes. However, efflorescence of some standing once cleaned off rarely forms again, so, for additional cost, this may offer one solution to the surface problem. Another, not so well adapted to the northern climate, is the training of ivy or other clinging vines to cover the entire outside walls.

However the matter of appearance is quite subsidiary to that of strength, and it is on the latter ground that some attacks have been made on the stand-pipe at Attleboro, and consequently on concrete stand-pipes in general. These attacks seem hardly to be fair, in view of the comparative water-tightness of the tank. If in similar work, particular attention is paid to the concrete and to the waterproofing of the lower 10 or 15 ft., where the pressure is greatest, danger from leakage should be eliminated.

In passing, we might remark that the contention made in our editorial some two years ago that there should be no ice formation inside the Attleboro stand-pipe, is confirmed by the testimony of the authorities there, based on three winters' observations.

For those who, in the present ascendancy of concrete, have forgotten that brick and terra-cotta are very excellent building materials, the column tests by Prof. Talbot which were reported in our last issue will furnish useful food for reflection. Tests of brick piers have been made before, in fair numbers, though there has always remained ground to complain of insufficient data on brickwork, as to strength and elasticity. There have also been some tests on terra-cotta. The Illinois series was well worth while, however, as a good analysis of the effect of hard burning, strong mortar and careful masons' workmanship. Incidentally it serves as a reminder that a brick pier is fully as strong as a concrete pier or column, even in such slender forms as a 12 × 12-in. pier 10 ft. high; also, that terra-cotta blocks will give a pier even a little stronger than brick, and well above the strength of plain concrete columns or piers. These are important points to remember. It seems that many have the subconscious feeling that a concrete column is much stronger than one of brick or terra-cotta, and believe also that the chief virtue of terra-cotta is its fire resistance.

The tests in question do not throw any light on the effect of different bond in brickwork. If our memory serves us, the few recorded tests on the value of bond are practically worthless. Yet wall masonry is probably much affected by the bond employed. To measure the nature and amount of this influence, however, the tests may not be made on small square piers, but rather on sections of wall. Further, resistance to vertical loads is not the chief value of bond, although the nature of the cracking of Prof. Talbot's piers—through the middle of the brick, apparently from bending action—indicates that even uniform vertical loads set up localized stresses in the masonry. The forces which count in relation to bond are those which set up shear along the wall, or those resulting from slight settlements. To make tests with these is doubtless a very difficult matter. They are rather necessary, however, since we read very generally in engineering literature that a high percentage of headers strengthens a wall, whereas masons assert that a maximum of stretchers is better, even to the extent of omitting headers altogether and tying the wall together by metal anchors.

Victory no longer attends Mayor Tom Johnson in his attempts to provide three-cent street railway fares and ultimate municipal ownership of street railways for Cleveland, Ohio. Refusing a readjustment plan which proposed a rehabilitation of the street railway system of Cleveland, with a maximum fare at the rate of seven tickets for 25 cts. and carefully-drawn provisions for lower rates of fare if the earnings warranted it, Mayor Johnson and his city council recently laid before the voters of Cleveland a franchise for still another street railway company. This proposition, known as the Schmidt franchise, embodied the three-cent fares and other ideals of Mayor Johnson. The referendum vote of Aug. 3 gave a negative majority of 3,763 out of a total vote of 66,044. The vote was unexpectedly light, inasmuch as a record registration of 97,000 and a hot campaign for and against the franchise had given reason for a heavy vote.

As nearly as can be judged by an outsider, the people of Cleveland had become tired of the long struggle waged by Mayor Johnson to reform the street railways in accordance with his pet ideas—good as many of these ideas may have been. Seemingly, they were ready for the compromise plan briefly outlined above, which had been drawn by Judge Robert Taylor, of the federal bench. The majority of that portion of the public that was sufficiently interested to vote on the subject recorded themselves as against adding to the existing tangle by granting still another street railway franchise. Presumably, the majority vote also meant that in comparison with good street railway service and the settlement of a long controversy which was dwarfing other municipal problems three-cent fare as against a maximum fare of 3 4-7 cts. and possible lowering of the latter figure had become an academic question.

We may be wrong. The struggle at Cleveland has been long, involved and bitter. Few persons who have not been in the fight understand its details, and if any of those engaged in the fight ever assumed a judicial attitude they seem to have abandoned it long since.

If we are even approximately right in sizing up the Cleveland situation then its lesson for would-be municipal reformers is don't be too insistent on carrying out your personal ideas to the exclusion of all other ways of reform; don't fear compromise where the differences of opinion are over troublesome questions of business and financial policy rather than over moral issues; for if you do you will tire out and cut off your friends and supporters.

Ornamentation in Engineering Structures.

We are glad to note repeated indications of a slowly progressing change in the views of German engineers and builders on the subject of ornament in engineering structures. Hitherto the course of events in Germany has uniformly evidenced the prevailing sentiment in favor of architectural elaboration of bridges, of dams, of halls, of water-tanks, even of chimneys—in short of every construction which depends essentially on modern technical methods rather than on those methods which we share with the ancient and medieval builders. Indeed, it seemed that this sentiment was becoming more insistent, more ubiquitous in its manifestations. The beholder could look forward, mentally, to an utter disappearance of plain, straightforward utilitarianism, to a time when the landscape of Prussia and Saxony would no longer be disfigured by straight chimneys, naked gas-holders, and bridges which by being just bridges missed their esthetic possibilities. But now signs of a revolt are in the air.

Written and spoken arguments, of architects as well as of engineers, are now making occasional plea for the abandonment of ornamentation, in favor of the unhindered expression of structural design in engineering works. There are some who go so far as to demand that all esthetic dogmas be abandoned in connection with such works; all, that is to say, except the most elementary guiding points such as symmetry where the governing conditions do not imply dissymmetry, regularity where variation is not implied, etc.

So a recent writer in one of the chief of Germany's technical journals makes argument in this sense, resting his claims on the obvious fact that beauty of form springs from the necessities of construction and cannot be transferred from one type of structure to another by transfer of

external form or clothing. He points to the abandonment of architectural ornamentation on machines, which, though absurd enough in our eyes, was a prime feature of scholarly design 25 to 50 years ago. There is a close parallel between this obsolete fashion and the practice of sticking turrets on bridges, or making water tanks look like Norman castles.

This utterance does not stand alone in recent German literature, and it is on this account, because it represents a drift, that it is important to note. More weighty by far, however, is the expression of such views in actual construction, where we find the proof that this drift is real and not merely academic. We may observe in recent German structures a growth toward plainness and simplicity, a less frequent and less obtrusive occurrence of ornamentation, and a less constant insistence upon making the so-called "esthetic viewpoint" a leading factor in design. Massive towers and frowning portals are not so often coupled to steel bridges. Turrets, panels, shafts, capitals, and finials more rarely adorn new constructive works. The practice of distorting natural outline to suit (supposed) requirements of beauty is sinking into the background. Even the old-fashioned belief that to make beautiful it is necessary to arch, to curve, is losing ground.

The drift is not all in one direction, it is true. There are movements of opposite trend also. Thus, a year ago there arose the problem of designing a dam, and it occurred to the interested authorities that the pretty valley in which it was to be built should not be disfigured any more than necessary; that the dam should be made beautiful, should be brought into harmony with the landscape as far as possible. An architectural competition was therefore held, to get the most beautiful composite of coping, roadway, face masonry and (most important of all) the gate-house. We do not need to add that the resulting designs were well adapted to give to the valley the appearance of an old battlefield marked by monuments of ghastly slaughter. The point is that such a competition of ornamentative genius should be held at all. And other recent instances of the same kind might be cited to show the continuing aberrations of esthetic prudery—the desire to veil and drape the engineer's naked works. But the drift toward reform is the more significant. It is a sign of new thought, and promises an ultimate change throughout.

American constructive practice, fortunately, has never been much hampered by the incubus of "beautification." The cast-iron-dogs-on-the-lawn spirit has never affected our engineering works. If we have, rarely, gone astray by building fantastic structures in a vain seeking for extrinsic beauty, we have built so many more specimens of construction great in their plainness as to redeem the error. Present prospects do not threaten a change in our public sentiment or engineering sense. We may look with pleasure, therefore, on the promise of reform in that transatlantic country which has hitherto exemplified the opposite and has consistently reproached our practice of ugliness.

LETTERS TO THE EDITOR.

Repairing Steel Tapes.

Sir: The method of repairing steel tapes, as told by Mr. W. H. Fuller in Engineering News for Aug. 12, 1909, p. 179, is excellent for tapes which are marked only at every foot or every five feet, but in the case of tapes divided into hundredths of a foot every ½-in. covered up obliterates just so many tape divisions, and after a few mends, it becomes almost impossible to make an accurate survey, and if not impossible the surveyor is very much handicapped by having to compare a piece of good tape with the poor to find out what the dimension is.

A tape mending outfit, consisting of some scraps of broken tape, a puncher or riveter, rivets, and a file, is very inexpensive and by applying the splice on the back the divisions are not covered up. Should the break be a bad one and a portion be missing the divisions on the splice can easily be matched with those on the tape to be mended and the gap bridged. By placing the rivet near the end of the splice and rounding the ends, no difficulty is experienced in having the tape catch in obstructions.

Anyone who has the "knack of it" may mend a tape thus in five to ten minutes, others in from fifteen to twenty minutes.

Yours very truly,

H. E. Cantwell.

New York City, Aug. 14, 1909.

An Enterprising Town.

Sir: In your issue of Aug. 5, 1909, p. 149, I note your editorial "Why do not railways put the names of their stations in a place where they can be seen by the average passenger on a passing train?" In one of the advertising magazines I noticed recently the following:

At Ottumwa, Iowa, within view of all passenger trains that stop at the C., B. & Q. depot, is a large billboard bearing the sign "This is Ottumwa, Iowa, the busiest manufacturing city in the Middle West. We have one of the largest pork packing plants and the largest hay machinery plant in the world. Over one-half of the coal mined in the state of Iowa is within 40 miles of Ottumwa." Following this is given a list of the kinds of factories in operation in the city, and the information that new ones are wanted.

It has occurred to me that Ottumwa, Iowa, deserves a little advertising on this very point, and in view of your editorial you may be interested to know that at least one city in the Middle West is thoroughly alive to the point you make.

Very truly yours,

Lawrence Wilson.

Monadnock Block, Chicago, Ill., Aug. 12, 1909.

Moment and Reaction Curves for Continuous Beams.

Sir: In some recent work involving continuous beams of two equal spans, reference was made to the formulas and diagrams printed in your issue of Jan. 30, 1908, p. 127, and it developed that the formulas and the diagram for the beam with a single load are incorrect.

The formulas should have r substituted for l (since the author used $k = r\,l$), so as to read,

$$R_1 = \frac{P}{4}(4 - 5r + r^3) \quad \ldots\ldots(1)$$

$$R_3 = -\frac{P}{4}(r - r^3) \quad \ldots\ldots(2)$$

In the diagram Fig. 2 of the article referred to, the curve giving the values of R_2 fails to take into account the effect of the negative R_3, whereas it is evident that the sum of R_1 and R_2 must be equal to the sum of P and R_3.

The critical moments are under P and over R_2 and are given by,

$$M_P = R_1 k = \frac{Pl}{4}(4 - 5r + r^3)\,r \quad \ldots\ldots(3)$$

$$M_{R_2} = R_3 l = \frac{Pl}{4}(r - r^3) \quad \ldots\ldots(4)$$

The curves of R_1 and R_3 are correctly drawn in Fig. 2 herewith. The curves cross at about $r = .375$, showing the reactions equal at that point with a value for each of .541 P or a sum for the two of 1.082 P. This corresponds to the sum of P and R_3 as shown by the curve for R_3.

An inspection of the moment curves, also drawn in Fig. 2, reveals the fact that M_P is always the greater of the two and that it is a maximum at about $r = .44$.

In the case of the overhung beam as given in the first part of the letter criticized, the use of two different ratios is confusing. In Fig. 1, herewith, values of R_1 ($= R_3$) and R_2 are given in terms of the same ratio as is used in the equation,

$$R_1 = R_3 = \frac{wl'}{8}(6\,r^2 + 8\,r + 3) \quad \ldots\ldots(5)$$

$$R_2 = lw - 2R_1 = \frac{wl'}{4}(5 - 6r^2) \quad \ldots\ldots(6)$$

in which $r = k/l'$.

The critical moments are given by,

$$M_{r1} = M_{r3} = -\frac{wk^2}{2} = -\frac{wl'^2}{8}\,4\,r^2 \quad \ldots\ldots(7)$$

$$M_{r2} = -\frac{wl'^2}{8}(1 - 2\,r^2) \quad \ldots\ldots(8)$$

$$M_{y1} = \frac{wl'^2}{8}\left(\frac{(6\,r^2 + 3)^2}{16} - 4\,r^2\right) \quad \ldots\ldots(9)$$

$$y_1 = \frac{l'}{8}(3 + 6\,r^2) \quad \ldots\ldots(10)$$

The curves, Fig. 1 herewith, show some interesting facts quite plainly.

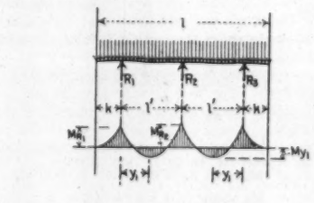
In the matter of reactions, aside from the familiar condition of zero overhang, the three reactions are found to be equal by the crossing of the reaction curves at the point where $r = .44$, and the reaction at the center becomes zero when $r = .913$. If r exceeds this amount the beam will rise from the middle support and will then cease to be one of two spans.

The moment curves for Mr_1 and Mr_2 indicate equality by their intersection at $r = .41$, while Mr_2 is zero at $r = .707$.

The maximum intermediate moment is shown by My_1 to be always greater than zero with a minimum at $r = .62$ while at $r = .913$ My_1 and Mr_2 become tangent, indicating that they become one and the same moment at the point where the beam is just ready to rise from the middle support. In addition the curve giving values of y_1, abscissas of points of maximum intermediate moments, indicates also that Mr_2 and My_1 are identical by showing y_1 equal to l' at the same value of r.

Comparison of the moment curves develops the fact that the greatest moment is always at the supports. Below a value of $r = .41$ the moment at the center support is the maximum while above this value of r the maximum is over the end supports.

1501 Monadnock Block, Chicago, Ill., July 15, 1909. G. F. Dodge.



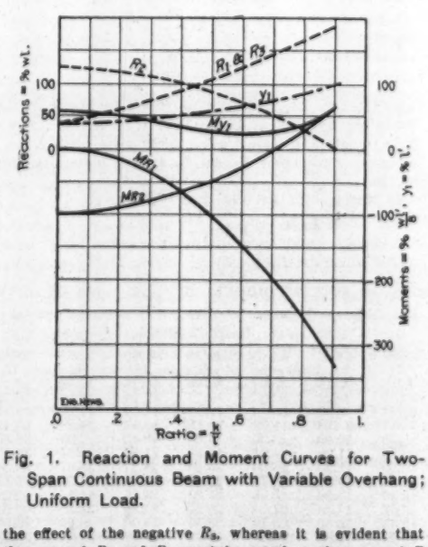
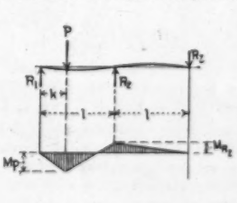


Fig. 1. Reaction and Moment Curves for Two-Span Continuous Beam with Variable Overhang; Uniform Load.



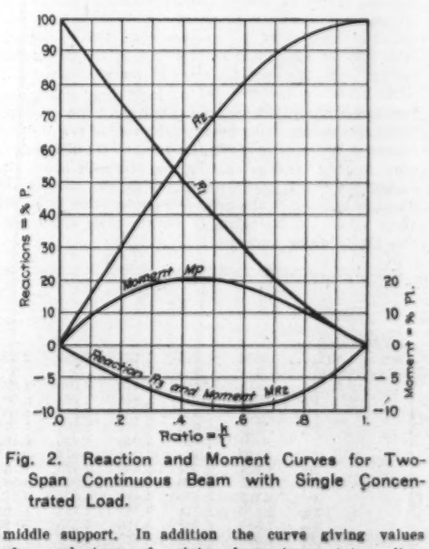


Fig. 2. Reaction and Moment Curves for Two-Span Continuous Beam with Single Concentrated Load.

Tables for Computing Eccentric Riveted Joints.

Sir: The article by Mr. E. W. Pittman in your issue of June 10, entitled "Some Faulty Details of Structural Steelwork," has suggested the use of the accompanying tables in the analysis of riveted joints for eccentric loads. [We reproduce one of the tables, that for ¾-in. rivets; the conversion factors noted below the table enable it to be used for other sizes.—Ed.] Having had occasion some time ago to design a number of structural steel brackets, these tables were prepared to facilitate the work.

The tables were computed on the basis of the following theory: In any eccentrically loaded group of rivets, as illustrated in the sketches adjoining, the rivets have to resist a moment $M = P\,L$, besides the direct load P. The unit-stress S_b in any rivet due to the moment, and the unit-stress S_d due to the direct load, combine according to the parallelogram law, giving the resultant stress S_r.

The direct shearing stress on the rivets is, per sq. in.,

$$S_d = \frac{P}{A}$$

where P is the load and A is the combined cross-section area of the rivets. The shearing unit-stress on the extreme rivet due to moment of eccentricity is

$$S_b = \frac{P\,L}{M}$$

where M is the section modulus of the group of rivets. The direct stress S_d is always parallel to the external force P, while the stress S_b is always at right angles to the line of rivets (see sketches Case 1—Case 4).

The section modulus of a single row of rivets, equally spaced, can be expressed by the following formulas:

If M = section modulus, in inches,
N = number of rivet spaces,
$N + 1$ = number of rivets,
a = cross-section area of one rivet, sq. ins.,
p = pitch of rivets, inches,

then, for odd number of rivets (even number of spaces)

$$M = 2a\left[p^2 + (2p)^2 + (3p^2) + \ldots\left(\frac{Np}{2}\right)^2\right] \div \frac{Np}{2}$$

$$= \frac{4\,a\,p}{N}\left[1^2 + 2^2 + 3^2 + \ldots\left(\frac{N}{2}\right)^2\right] \qquad (1)$$

while for even number of rivets (odd number of spaces),

$$M = 2a\left[(0.5\,p)^2 + (1.5\,p)^2 + (2.5p)^2 + \ldots\left(\frac{Np}{2}\right)^2\right] \div \frac{Np}{2}$$

$$= \frac{4\,a\,p}{N}\left[0.5^2 + 1.5^2 + 2.5^2 + \ldots\left(\frac{N}{2}\right)^2\right] \qquad (2)$$

In these formulas the moments of inertia of the rivets about their own axes have been neglected.

Using formulas (1) and (2) a table was computed giving the values of section modulus for all pitches and all numbers of rivets up to 20. A separate table was computed for each of the common sizes of rivet, but any table may be adapted to another size by multiplying by the ratio of cross-sectional areas of the rivet sizes.

The table applies directly to single-shear conditions. For double shear, the section moduli are twice as large. When the bearing value governs, the moduli are in effect decreased by the ratio of bearing value to shearing value; when bearing value governs in case of double shear, the moduli for double shear (twice the tabular values) are similarly reduced in the ratio of bearing value to double shear value. In designing, to use the table direct, employ the following formulas:

(A) Rivets in single shear that would fail by shearing:

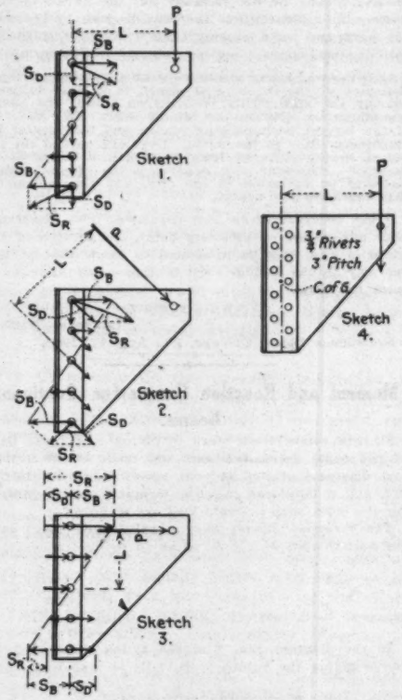
$$\text{req. } M = \frac{PL}{S_b}$$

$$S_d = \frac{P}{A}$$

(B) Rivets in double shear that would fail by shearing:

$$\text{req. } M = \frac{PL}{2\,S_b}$$

$$S_d = \frac{P}{2\,A}$$



(C) Rivets in single shear that would fail by crushing:

$$M = \frac{PL}{S_b} \times \frac{s}{b}$$

$$S_d = \frac{P}{A'}$$

where s = shearing value of one rivet
b = bearing value of one rivet
A' = combined area of rivets in bearing.

(D) Rivets in double shear that would fail by crushing:

$$M = \frac{PL}{2\,S_b} \times \frac{s}{b}$$

$$S_d = \frac{P}{A'}$$

EXAMPLE.—For a bracket as shown in Sketch 1, the conditions are: P = 14,000 lbs.; L = 10 ins.; rivets ¾-in.; angle and plate $^5/_{16}$-in. thick; rivet pitch 3 ins.; resultant rivet shear S_r not to exceed 10,000 lbs. per sq. in.

As single shear governs (See "A" above),

$$M = \frac{PL}{S_b}$$

or, assuming S_b about 9,000 to keep S_r below 10,000,

$$M = \frac{14{,}000 \times 10}{9{,}000} = 15.5$$

In the table opposite 3-in. pitch the nearest value is 15.9, for 8 rivets. If 8 rivets are used

$$S_d = \frac{P}{A} = \frac{14{,}000}{8 \times .442} = 4{,}000 \text{ lbs. per sq. in.}$$

$$S_b = \frac{PL}{M} = \frac{14{,}000 \times 10}{15.9} = 8{,}800 \text{ lbs. per sq. in.}$$

These stresses act at right angles; their resultant is

$$S_r = \sqrt{4{,}000^2 + 8{,}800^2} = 9{,}700 \text{ lbs. per sq. in.,}$$

which falls below 10,000 as specified. If S_r had exceeded 10,000 it would have been necessary to assume a lower value of S_b, i. e., use more rivets.

In cases such as shown in Sketches 2 and 3, the distance L is not known in advance of design, but depends on the number and pitch of the rivets.

The tables apply strictly to one line of rivets, but they may be used with no perceptible error for two lines of rivets close together, as in Sketch 4. In the bracket sketched, for instance, the total section modulus would be the sum of the tabular value of 5 rivets plus that for 6 rivets, or, from the table, 6.63 + 9.28 = 15.91. The moment arm L in this case is the distance from the load to a line passing through the center of gravity of the group of rivets, as shown.

Monroe R. Hull,

1225 Fourth Ave. North, Great Falls, Mont., June 28, 1909.

A Novel Condenser Design.*

By EDWIN YAWGER.†

At the time of the introduction of the steam turbine it was said that a very high vacuum would improve turbine economies to an extent hitherto impossible with reciprocating engines. This naturally stimulated development among condenser designers. It became evident at once that the old types, which were good enough for a 25 and 26-in. vacuum, would be practically useless where the requirements called for a vacuum of 28 or 29 ins. While many refinements thus far have been made in all features of condenser design, they have been generally along the lines of former practice. The principal improvement adopted by practically all manufacturers has been to apply a separate dry vacuum pump for the removal of air and non-condensable vapors.

The dry vacuum pump, as commonly constructed, is a direct steam-driven reciprocating unit, with its air cylinder and valve mechanism designed to reduce as far as possible the return to the condenser of the compressed air from the clearance spaces. When it is realized that the air flowing back from the clearance will exceed many times the original volume, it becomes evident that the ideal vacuum will never be reached by the reciprocating type of pump.

In the effort to overcome these inherent defects builders have resorted to numerous refinements. Air cylinders are water-jacketed to prevent overheating. Mechanically-operated air valves are used to decrease the difference in pressure between condenser and pump cylinder, which had to be sufficient to lift voluntary valves from their seats. Two air cylinders are sometimes put in series, which manifestly improves the efficiency. An additional set of "flash" ports is sometimes introduced in the air valve itself to permit the air, compressed in the clearance, to be almost instantaneously discharged, not into the condenser, but into the opposite end of the cylinder, just before the suction valves open. This last

*Revised from a paper before the convention of the Association of Iron and Steel Electrical Engineers, Buffalo, N. Y., June 24, 1909.

†Westinghouse Machine Co., East Pittsburg, Pa.

TABLE OF SECTION MODULI OF ONE LINE OF RIVETS.

For Different Numbers of Rivets and Different Spacings.

¾-IN. RIVETS.

Pitch	Area of rivets, sq. ins.	.8836	1.325	1.767	2.209	2.650	3.092	3.543	3.976	4.418	4.859	5.300	5.743	6.184	6.627	7.068	7.510	7.952	8.394	8.836
	No. of rivets....	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	.4418	.8836	1.473	2.209	3.093	4.123	5.302	6.627	8.100	9.719	11.48	13.40	15.46	17.67	20.03	22.53	25.18	27.98	30.93
	1¼	.5522	1.104	1.841	2.762	3.866	5.153	6.627	8.283	10.12	12.14	14.36	16.75	19.32	22.08	25.03	28.16	31.47	34.97	38.66
	1½	.6627	1.325	2.209	3.315	4.639	6.184	7.953	9.940	12.15	14.57	17.22	20.10	23.19	26.50	30.04	33.79	37.77	41.97	46.39
	1¾	.7731	1.546	2.577	3.867	5.412	7.215	9.278	11.59	14.17	16.98	20.08	23.45	27.05	30.92	35.05	39.42	44.06	48.96	54.12
	2	.8836	1.760	2.946	4.420	6.186	8.246	10.60	13.25	16.20	19.43	22.96	26.80	30.92	35.34	40.06	45.06	50.36	55.96	61.86
	2¼	.9940	1.988	3.314	4.972	6.959	9.276	11.92	14.91	18.22	21.83	25.81	30.15	34.78	39.75	45.06	50.69	56.65	62.95	69.59
	2½	1.104	2.209	3.682	5.525	7.732	10.30	13.25	16.56	20.25	24.27	28.67	33.50	38.65	44.17	50.07	56.32	62.95	69.95	77.32
	2¾	1.215	2.429	4.050	6.077	8.505	11.31	14.58	18.22	22.27	26.70	31.52	36.85	42.51	48.59	55.08	61.95	69.24	76.94	85.06
	3	1.325	2.650	4.419	6.630	9.279	12.36	15.90	19.88	24.30	29.15	34.44	40.20	46.38	53.01	60.09	67.59	75.54	83.94	92.79
	3¼	1.436	2.871	4.787	7.182	10.05	13.39	17.23	21.53	26.32	31.55	37.30	43.55	50.24	57.42	65.09	73.22	81.83	90.93	100.5
	3½	1.546	3.092	5.155	7.735	10 82	14.43	18.55	23.19	28.35	34.00	40.19	46.90	54.11	61.84	70.10	78.85	88.13	97.93	108.3
	3¾	1.656	3.313	5.523	8.287	11.59	15.46	19.88	24.85	30.37	36.43	43.03	50.25	57.97	66.26	75.11	84.48	94.42	104.9	115.9
	4	1.767	3.534	5.892	8.840	12.37	16.49	21.20	26.50	32.40	38.87	45.92	53.60	61.84	70.68	80.12	90.12	100.7	111.9	123.7
	4¼	1.877	3.755	6.260	9.392	13.14	17.52	22.53	28.16	34.42	41.28	48.80	56.95	65.70	75.09	85.12	95.75	107.0	118.9	131.4
	4½	1.988	3.976	6.628	9.945	13.91	18.55	23.85	29.82	36.45	43.70	51.62	60.30	69.57	79.51	90.13	101.3	113.3	125.9	139.1
	4¾	2.098	4.197	6.996	10.49	14.69	19.58	25.18	31.47	38.47	46.13	54.50	63.65	73.43	83.93	95.14	107.0	119.6	132.9	146.9
	5	2.209	4.418	7.365	11 05	15.46	20.61	26.51	33.13	40.50	48.59	57.40	67.00	77.30	88.35	100.1	112.6	125.9	139.9	154.6
	5¼	2.319	4.638	7.733	11.60	16.23	21.64	27.83	34.79	42.52	51.00	60.22	70.35	81.16	92.76	105.1	118.2	132.1	146.8	162.3
	5½	2.430	4.859	8.101	12.15	17.01	22.67	29.16	36.44	44.55	53.45	63.10	73.70	85.03	97.18	110.1	123.9	138.4	153.8	170.1
	5¾	2.540	5.080	8.469	12.70	17.78	23.70	30.48	38.10	46.57	55.90	66.00	77.05	88.89	101.6	115.1	129.5	144.7	160 8	177.8
	6	2.650	5.300	8.838	13.26	18.55	24.73	31.81	39.76	48.60	58.31	68.88	80.40	92.76	106.0	120.1	135.1	151.0	167.8	185.5

NOTE.—For any other rivet size, multiply values from this table by:

⅝-in.	½-in.	⅝-in.	⅞-in.	1-in.
.2498	.444	.694	1.361	1.777

expedient would at first seem to go a long way toward removing the bad effect of clearance if it did not in a measure defeat itself. The sudden expansion resulting from this action causes a re-evaporation of the moisture always present on the walls of the cylinder, and, hence, no air can enter from the condenser until the piston has traveled far enough to equalize the pressure. The net result of the combination of all such expedients as noted is to impose a burden of first cost and maintenance that will overbalance the doubtful benefits to be secured by extreme complication.

A New Type of Condenser.

The Leblanc condenser bears the same relation to the familiar type of condensing apparatus that the steam turbine does to the reciprocating engine. It is in fact a "turbine-type" of condenser and occupies only a small fraction of the space formerly allotted. It develops higher vacuum, not by the multiplication of parts, but through a simple application of rotary motion, with no reciprocating or rubbing parts and no valves of any description.

The Westinghouse-Leblanc condenser is the commercial development of one of the inventions of Prof. Maurice Leblanc, a distinguished French scientist, who is perhaps best known to Americans on account of his electrical work. Among his more important electrical inventions, may be mentioned the copper "damper" or "amortisseur," extensively used on alternating current generators, which brought his name very prominently before the public some ten years ago when the problem of operating alternators in parallel was the all-absorbing topic with which electrical engineers were concerning themselves.

In 1900 Mr. George Westinghouse secured control of Prof. Leblanc's inventions for his French company, Société Anonyme Westinghouse, and enlisted his personal services. The Leblanc patents became so numerous and so basic that their exploitation and the granting of licenses under them became so important as to warrant the formation of a company to care for this business exclusively. This company is known as the "Societe pour l'Exploitation des Procédés Leblanc." Prof. Leblanc is consulting engineer to the French Westinghouse company and is also professor of physics in the Ecole des Mines, at Paris. His versatility is shown by the fact that he formerly occupied the chair of mathematics in this school and is qualified to hold the chair of chemistry or astronomy.

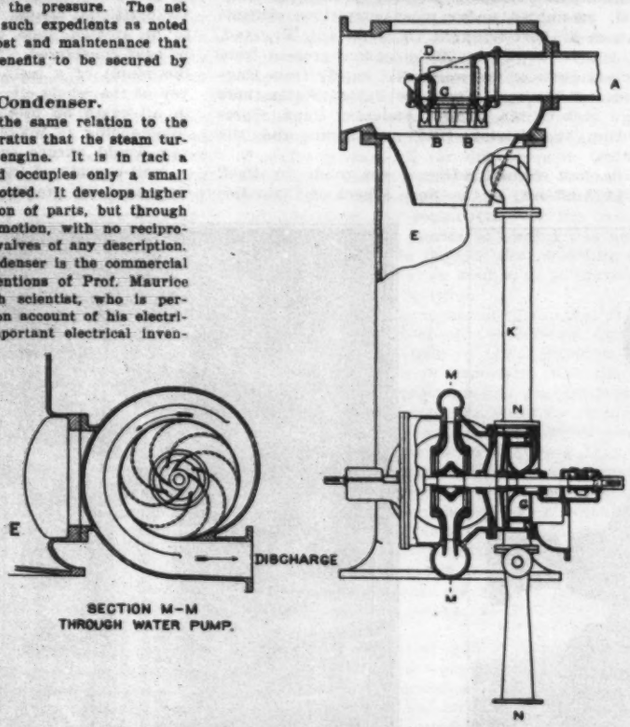


FIG. 1. SECTIONS OF LEBLANC CONDENSER AND PUMPS.
(Made by Westinghouse Machine Co., East Pittsburg, Pa.)

ESSENTIAL FEATURES.—The first striking characteristic of the Leblanc condenser is its compactness and simplicity. While it employs the excellent feature of separate removal of water and air, its functions are performed by a pair of small turbine-type rotors on a common shaft and in a single unit casing which is integral with the lower portion of the condensing chamber. The condensing chamber is of small diameter, being but slightly larger than the exhaust opening of the engine or turbine.

These elements are all discernible at a glance, but the preeminent superiority of the Leblanc system over all others lies in the practically perfect removal of air and non-condensable vapors.

A general sectional view of the standard Westinghouse-Leblanc condenser is shown in Fig. 1. Exhaust steam enters at D and cooling water entering through the pipe A, is projected downward through spray nozzles B. The injection water and condensed steam flow to the centrifugal discharge pump M under a head of 2 or 3 ft., which insures positive filling of the pump. The exhaust steam is drawn downward and condensed by the water spray. The space E above the water is occupied by water vapor, plus the air released from the injection water and from the exhaust steam. This space communicates with the air pump N through the pipe K.

THE AIR PUMP.—The principle is new, and the pump differs from all ejector-type pumps or, aspirators, which depend on friction for the entrainment of air. A section of the pump is shown in Fig. 2. The Leblanc pump projects a series of slugs or water pistons through the discharge nozzles, each piston forcing ahead of it a small pocket of air.

The air mingles with the water in the lower portion of the nozzle, but the speed is such that no part of it ever finds its way back towards the condenser. In other words, there is no leakage past the piston. The initial pocketing of the air between the successive layers of water is positive and, as will readily be seen, the vacuum-neutralizing effect of clearance is entirely eliminated. The water supply for the air pump may be taken from the main water inlet or a supply may be placed in a tank and used over and over in the air pump. Since the air-pump water is in communication with the condenser, it is drawn by suction into an annular chamber, which is overhung by the buckets of the pump retort. The water passes out of the chamber through a port and is projected downward in a rapid succession of water pistons. At the lower end of the air-pump nozzle there is placed an auxiliary ejector nozzle to which is connected a steam pipe. In starting up the condenser, steam is first turned into this auxiliary nozzle for a few moments, creating a sufficient vacuum to start the regular flow of water through the air pump. Where the level of the air-pump water supply is 3 or 4 ft. above the basement floor, the pump may be started without this use of steam.

As will be seen from Fig. 1, the air-pump rotor and the main-pump runner are enclosed in a common casing and mounted on the same shaft. There are only two bearings and the shaft glands are made air-tight by water seals.

COUNTER-CURRENT ACTION.—The term "counter-current principle" is often applied to cooling apparatus so designed that the substance to be cooled is subjected to the full effect of the lowest temperature of the cooling medium at the moment of withdrawal of the former from the cooling chambers. Thus, in a surface condenser, the water is introduced at the top and the exhaust steam at the bottom. The latter, rising to the top, is exposed to the entering cold water. The air, which is always present, being non-condensable, is little affected by this final cooling, but the effect on the final volume of steam is remarkable, a much greater proportion of it being condensed in the cooler region and the air pump, instead of handling a certain volume of air plus a relatively large volume of water vapor, is enabled to draw out a mixture from which a large part of the vapor has been eliminated.

This action is easily illustrated. If we have a condenser with little counter-current action, taking injection water at 70° F., maintaining a vacuum of 28 ins. (steam temperature, 101.3° F.), with 1 lb. of air entering per minute and being removed at 90°, then the mixture of air and vapor is only partially cooled (from 101.3° to 90° instead of to 70°). To find the volume of the natural mixture of air and vapor at 90° and 70° it is only necessary to go back to Dalton's law that the pressure of a mixture of gases is the sum of the pressures each gas would exert alone in the given volume. The steam, to be saturated, must exist at a pressure corresponding to 90° or 70°, and this fixes its proportion of the total pressure existing under the vacuum of 28 ins. The pressure of the air then is for 90°

$$0.980 - 0.696 = 0.284, \text{ and}$$

Vol. per lb. = 717 cu. ft.

The pressure of the air in the mixture, for 70°, is

$$0.980 - 0.363 = 0.617, \text{ and}$$

Vol. per lb. = 317 cu. ft.

Thus it is evident that the capacity of the air pump necessary to handle the inevitable mixture of air and vapor at 70° is only 44% that required for a mixture at 90°

These relationships remain the same whether a surface or jet condenser is used. The Leblanc air pump, applied to either type, with its cold water supply, combines expulsion of the air mixture with cooling to the point of minimum volume, and even with actual condensation of steam by the pump water.

Indeed, for units smaller than 300 HP., it is customary to eliminate the main condensing chamber and pass all the exhaust steam as well as the air through the air pump only. For this service, the air pump is slightly modified, a relatively greater amount of water being used to best expel the air and condense the steam in one operation. The same high efficiency is maintained and the apparatus occupies scarcely more space than that required for the exhaust pipe alone. Fig. 3 shows a vertical steam engine equipped with one of these small condensers, which is belt-driven from the engine shaft.

For use with surface condensers, both stationary and marine, and for application to barometric and other types of jet condensers, to evaporating pans, etc., the air pump is furnished separately. Embodying as it does, the vital element of the Leblanc system, its application in any situation requiring an efficient vacuum will insure a marked improvement in the effectiveness of the entire equipment.

POWER REQUIREMENT.—The pumps are usually driven by a steam turbine, and under ordinary conditions require from 2 to 3% of the power generated by the main engine. The exhaust from the condenser turbine is utilized for heating feed water, and when combined with the exhaust of other plant auxiliaries the quantity is just about sufficient to maintain a feed-water temperature of 212° F., at the boilers supplying steam to the prime mover served by this condenser.

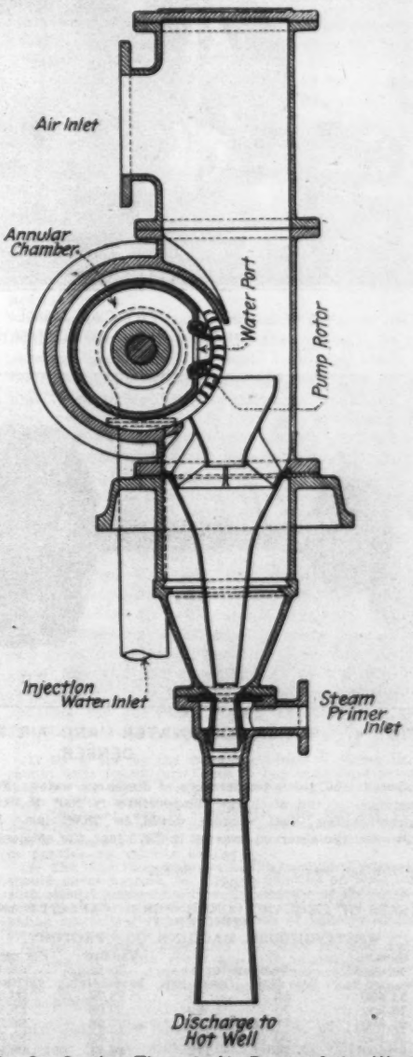


Fig. 2. Section Through Air Pump of the Westinghouse-Leblanc Condenser.

In cases where economisers are used, or where there may be extra sources of exhaust steam, it would be ad-

visable to operate the condenser pumps, by an electric motor, as in Fig. 3.

The main pump is commonly designed to discharge against only a few feet head, sufficient to overcome friction in the discharge line. If it is desired to elevate the water to the top of cooling towers, or other moderate elevations, the pump can readily be modified to meet the additional duty.

THE FIRST YEAR'S RECORD.—At the present writing there have already been contracted for in this country over 60 Leblanc condensers for services aggregating 75,000 HP. Most of these serve turbines of various types, but a few, especially in small sizes, are used with reciprocating engines. Typical results obtained from two plants are set forth in the accompanying table.

Efficiency is here expressed by the percentage of perfect vacuum actually obtained. The highest vacuum possible equals the exterior air pressure less the tension of water vapor at the given temperature of discharge water. For instance, if the discharge temperature is 100° F., the corresponding ideal vacuum would be 28.08 ins. If, however, the observed vacuum is 27.75 ins., the efficiency percentage would be $\frac{27.75}{28.08} = 98.8\%$.

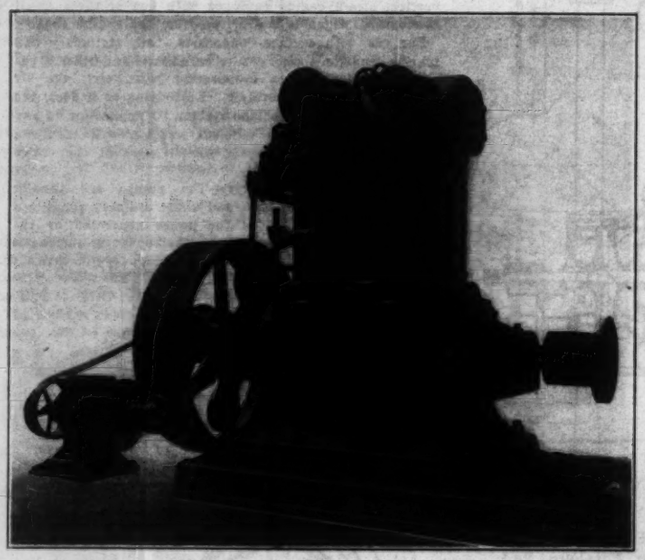


FIG. 3. WESTINGHOUSE VERTICAL SINGLE-ACTION ENGINE WITH LEBLANC PUMP-CONDENSER UNIT.

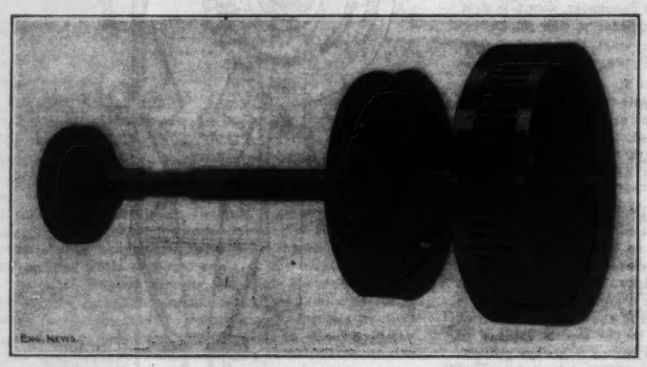


FIG. 4. ROTOR OF WATER AND AIR PUMPS, LEBLANC CONDENSER.

TESTS OF LEBLANC CONDENSERS. CAPACITY AND EFFICIENCY.

WESTINGHOUSE MACHINE CO., FACTORY.

Steam condensed, lbs. per hr.	Temperatures—Injection.	Temperatures—Discharge.	Vacuum, 30-in. barometer.	Per cent. ideal vacuum.
11,400	65	79	28.76	99.5
18,300	70	92	28.09	98.8
25,000	71	97	27.96	99.3
32,100	70	104	27.59	99.3
38,600	70	112	26.81	98.8
11,300	53.3	72	29.06	99.5
18,300	50.5	86.3	28.44	99.4
25,000	62.3	94	28.21	99.7
32,100	65.5	103	27.51	99.0
37,500	54.0	102	27.56	99.0

JERSEY CENTRAL TRACTION CO., KEYPORT, N. J. (Rated Capacity, 8,380 lbs. steam condensed at 27 ins. vacuum and 90° injection temperature.)

5,680	85.5	100.5	27.8	99.1
9,200	87.0	108.0	27.3	99.1
12,000	88.0	120.0	26.4	99.4
15,000	87.0	124.0	26.1	99.7
19,000	87.0	139.0	24.0	98.9

The National Town Planning Congress at Port Sunlight and Southport, Eng.

By FREDERICK L. FORD,* M. Am. Soc. C. E.

The National Town Planning Congress, held by the National Housing Reform Council of England, assembled under most auspicious circumstances at Port Sunlight (Birkenhead), England, on Aug. 4, with over 200 delegates present from various parts of the world, but chiefly from England and Scotland. From the United States there were present Mr. Robert Anderson Pope, representing the Boston 1915 movement, and the writer.

The first formal address was made by Prof. S. D. Adshead, of the New School of Civic Design of Liverpool University, founded by Mr. W. H. Lever. Mr. Adshead said that the creation of civic environment must not be allowed any longer to be regarded as a matter entirely of individual interest; it must be recognized more as a matter of public responsibility. He hoped that the Town Planning bill, now before the British Parliament, would be followed by a series of other bills directed to securing public control of environment, and he believed that if wisely directed the operation of the bill would exert an influence not only on the physical but also on the moral and intellectual life of the community of a nature more real and direct than any other measure of reform within recent years. In determining the character of the buildings which are to be placed upon certain sites under the Town Planning Bill, he hoped that buildings of an objectionable character would be prohibited, meaning buildings offensive to the sense of sight, such as the interminable terrace of speculating builder's design, those obviously designed as advertisements, and intruding, either as irregular monstrosities in form, as vicious exhibitions of color, or as vulgar expressions of other kinds.

In developing outlying areas, Professor Adshead thought that the boundaries should always be influenced by some natural or historic line of demarkation; as a water-course, an old road, or the edge of a wood. Outlines which follow ridges or centers or valleys should be avoided, as far as possible, as these should form the centers of the divisional layout. Then the class of property to be erected upon the various sections should be next considered. This should be influenced by the result of a well-considered sociological survey of the whole city, which, to his mind, should in all cases be prepared by every town before commencing to make town plans. Such a survey would ensure each zone or district having a well-considered reference to the whole. In Germany the statistician assists largely in the preparation of town plans. Professor Adshead thought that certain areas should be utilized for distinct and separate uses, such as residential areas for different classes and industrial areas for different industries. After calling the attention of the Congress to the way in which large cities like London are divided into separate boroughs, each with its own local center, he stated that each of these subsidiary centers should have its church, its public hall, its almshouses, schools, shops and village green. Close around these, and each with its garden, in close proximity to a park, or place of recreation, would be the dwellings of the workers. Professor Adshead said that in planning the future of an existing town not only is it necessary to consider the laying out of fresh tracts of country, but much thought and energy must be devoted to the destruction of what already exists, referring particularly to slum property of any class and also to hideous railway encroachments, which have cut up the approaches to cities in a most disastrous way.

In concluding, Professor Adshead dwelt on the units of the suburbs, stating that first we must have cottages for the working class, and these should in the best sense of the word be the embodiment of a simple life. The gardens should be planted with old-world plants and bushes and the apartments furnished, everyone for use. The cottages should be approached by grass-bordered

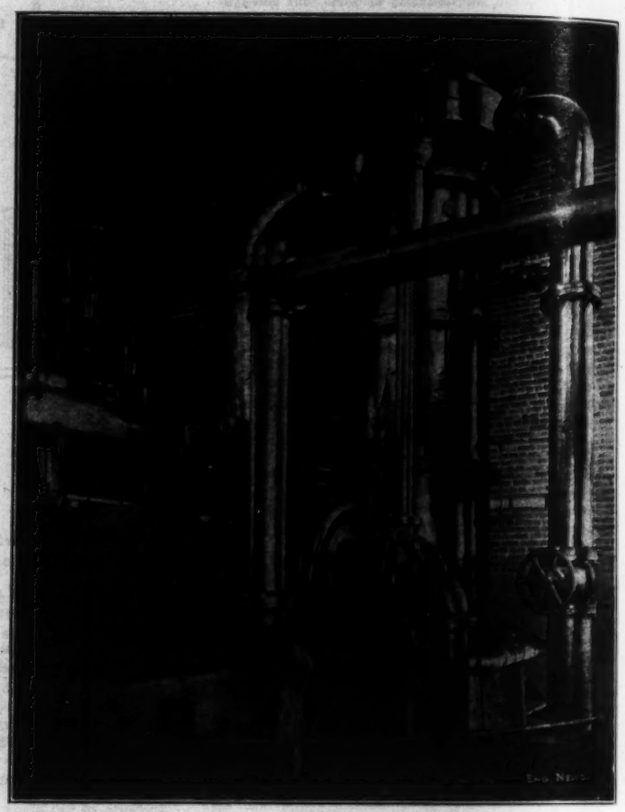


FIG. 5. WESTINGHOUSE-LEBLANC CONDENSER, SERVING A 1,000-KW. TURBINE.

Bristol Gas & Electric Co., Bristol, Tenn.

*City Engineer, Hartford, Conn.

paths and the roads should be the simplest of well-kept tracks. For the residences of the middle class he advocated a more formal and refined type of architecture like that of fifty to a hundred years ago, when refinement of manners, scholarship and good taste attained to a very high standard amongst those responsible for building development. As the houses of the rich would naturally be isolated and of great variety of taste, each would be a scheme in itself and only incidentally affect the town plan.

Mr. T. H. Mawson, Lecturer on Landscape Design at Liverpool University, in a paper entitled "Town and Country," advocated the retention of old-time associations in the development of towns as far as possible, although it is recognized that the methods of the country cannot be wholly applied to modern city life. He did not believe that country methods should be carried into the towns, nor those of the city into the country. He said that civic art has a mission and that we are awakening to the educational value which the impress taken from the surroundings has in quickening the mental faculties of the young to teach them to detect truths hidden behind the material presentments.

Professor Berlepsch von Valendas, of Munich, addressed the convention on "Town Planning in Ancient and Modern Times." He stated that no greater difference can be found than that between our age and that of any period of the past in reference to town planning. During the different ages of the past the principle of the greatest protection against attack from the outside found expression in the building of a circle of fortifications and the placing of certain boundaries to local extension. In our time the principle of unlimited expansion prevails. More attention is now being paid to securing radical hygienic regulations, to improving the faulty condition of the old towns by better sewerage and providing good drinking water, by making available air and light and by limiting the exceeding closeness of the buildings.

The housing question stands in the most intimate connection with everything which to-day is comprehended under the title of town planning, because in the domain of the protection of health it makes the most imperative demands. Certain principles in town planning remain constant, such as the architecture of public and private buildings in their relation to the streets, the construction of streets in respect to public places, and the erection of fountains, of monuments and of works of combined architecture and sculpture, in relation to the surrounding architecture. Town planning should, in his opinion, first provide the greater part of the population with good, cheap, healthy and modest artistic dwellings. Government institutions should endeavor to secure to the man not only insurance against illness, invalidity and the infirmity of old age, but in his days of health, above all, the certainty of a family life free from defect, the assurance that his children may become capable citizens and not candidates for the penitentiary and the gallows. Dwellings fit for men accomplish more than whole books full of moral laws, or an army of moral inspectors who live from the money of the taxpayer. In order that the town should be able to be master of its own development he said the state should endeavor to acquire as much land as possible for the public weal. In order to secure the proper development of new suburbs, the following principles should be borne in mind:

(a) The restriction of the number of houses or rooms to be placed upon the land. In this way a most valuable restriction can be placed in regard to the density of population.
(b) The consideration of aspect in order that the maximum amount of sunshine may be secured for houses.
(c) Consideration of the prevailing wind in order that proper ventilation may be secured.
(d) Consideration of existing main roads.
(e) Careful provision of spaces for public buildings.

Later in the day Professor Adshead and Mr. Mawson explained the scope of the courses to be provided in the New School of Town Planning and Civic Design, and Professor Reilly delivered an illustrated lecture on the plans for the improvement of various American cities, paying special attention to the recent report on the future development of the city of Chicago and to similar reports on Washington, Cleveland, St. Louis and Buffalo. The second session of the Congress was held in the town hall at Southport, the delegates being welcomed by the deputy mayor and the Southport town council.

The first speaker of the morning was Professor Eberstadt, Professor of Economics at Berlin University, who has been called "the arch enemy of insanitary housing in Germany." He warned English housing reformers against letting town planning fall into the hands of private and unscrupulous interests, and declared that town planning was a problem of economics rather than of architecture. All the difficulties in Germany came from the fact that land was from five to seven times as expensive as that in England, and, therefore, the construction of the barrack-type of house, five stories in height, was an absolute necessity. He thought that a sliding scale tax might be imposed on land so as to prevent its excessive increase in value.

Mr. T. C. Horsfall, author of "Examples of Germany," stated that of all the reforms that can be effected by the help of town planning there is certainly none more important than the supplying of a sufficient number of playgrounds and planted open spaces in the districts chiefly inhabited by working people, and quoted several American authorities to substantiate this contention. It is of immense importance that all who have any connection with the making of town plans shall from the first seek to make impossible the substitution of tenements for one-family houses. Safeguards must also be provided against the rise in the price of urban and suburban land, against the increase in the cost of building and the consequent increase in rents of houses.

The excessive cost of land in many of the German cities, which is from five to seven times as great as in English cities, is largely due to the excessive width of the city streets, 74 ft., 85 ft., and 112 ft., being common for streets through which little traffic passes; while in English towns many streets of a similar character are not more than 36 or 39 ft. in width.

Mr. Horsfall stated that two of the uses made of town plans in Germany are wholly good and should certainly be adopted by England. In German town plans every street through which it is probable that much traffic will pass is laid out of sufficient width for the expected amount of traffic so that the inhabitants of German towns are spared that most useless kind of expenditure on which in England millions of pounds have been wasted—the purchase at very high prices of the property on one side of a street, only a few years old, for the purpose of giving to the street the width which it should have had at the beginning. In the case of streets which will have much traffic through them eventually, but which are not likely to be much used for some years, the streets in Germany are laid out of sufficient width between the two lines of buildings for the needs of the largest amount of traffic expected, but only the width of road immediately needed is paved, and the builders of houses have to provide front gardens and surrender them for incorporation in the street when the first paved portion of the street is found insufficient for the increasing traffic.

A very interesting paper on "Consideration of the Fundamental Conditions Which Should Govern Town Extension Planning in Great Britain," was presented by Monsieur Augustin Rey, architect, of Paris. Mr. Rey cautioned the delegates against the adoption in any country "en bloc" of the plans used in any other country without first deciding whether they are thoroughly applicable to local conditions. Years of careful study should be made of the lives of the people, their habits and the climatic conditions of each country before determining the conditions under which the people should be housed, as the variety of climatic conditions impose a variety of methods in preparing town extension plans. Mr. Rey grouped the present town expenditures under the following four categories:

(1) Cost of land occupied by public roads, free spaces and parks and public buildings.
(2) Cost of constructing streets, water-supply and other similar works of public service, and specially the maintenance of public parks.
(3) Cost of general municipal administration.
(4) Cost of health and hygiene administration in the different parts of the city.

He stated that the uninterrupted increase in the price of urban land which he found operating everywhere in great cities, adversely affects the municipal budgets of such cities and the lack of municipal means affects all matters concerning the development, and specially the hygiene, of the city. Instead of using capital to legitimatize and consolidate the growing price of land in the city, the municipal authority should use all its resolution, all its intelligence and all the capital it can raise for the purpose of improving the conditions of the working-class quarters and increasing by every possible means the value of the capital of life—a capital which in a progressive community should be always increasing and improving. It is this increase in the value of human life which is essentially the capital of the people—and not the increasing value of the land on which they live. It should be recognized that in order to produce their full fruits the preparation of town extension plans should be directly related to the purchase of great areas of land at uninflated prices by municipalities in the interest of the general public. The law should clearly authorize and definitely encourage local authorities to deal with the problem in this way. Most certainly they should not be compelled, as at present, to seek the permission of the central authority before making these purchases.

Ulm, Germany, has realized that this question of the land is at the root of the housing question, and that it is only by keeping down the price of land over a long period of years that the healthy house can be created and maintained. To-day Ulm actually possesses 80% of the total area of the town and leases land for a hundred years, and in addition lends the greater part of the capital for the construction of the houses, and at the end of the leasehold period the town will be able to purchase the houses at their actual value.

The success of town extension depends on the solution of this question of cheap land. In possessing large areas of such land the town can be the master in determining the price of land and in securing the execution of works of general well-being. It is not by providing perspectives and grandiose monuments that we shall make our cities healthy and our people happy, as this method of planning simply creates in the public mind a false conception of grandeur and one not related to simple home life. Mr. Rey urged that peaceful warfare should be waged against the block dwelling.

In closing, Monsieur Rey suggested that the most practicable means of giving to a town expansion plan an indisputable hygienic value is by limiting the number of persons per acre in order to completely avoid the overcrowding of dwellings and the shutting out of air and light from such dwellings, and summarized the essentials for successful town extension planning for England as follows:

(1) By a law of the state the cities of Great Britain should have special privileges to buy land (and if necessary all the land) whether situated in their boundaries or in a wide suburban area.
(2) In order not to overburden the budgets of the municipalities the purchase of such land—the price of which should be fixed by special commissioners—should be payable by annuity bonds.
(3) The land thus included in the municipal possessions should never be sold, but let for building on long leases, with special clauses limiting the number of houses to the acre, prescribing conditions in regard to rent and providing specially for the construction of suitable dwellings for the people.
(4) In all future purchases the price of land for the widening of public roads and for procuring sites for public buildings should be in a direct relation to the value of the land already acquired for the purpose of town planning.

Mr. Raymond Unwin, architect, of Hampstead Garden Trust and First Garden City, Letchworth, in addressing the congress, stated that in planning new developments first consideration should be given to the main lines of communication, such as streets, railroads, canals and other transit facilities, and the degree of density of population which is to be allowed in each particular district. At Hampstead and Letchworth twelve cottages have been adopted as the maximum number per acre.

He suggested the following actual requirements for roadways: First, a footpath only providing sufficient access to small groups of cottages adjacent to main roads where the cottages are built round a small green or in short groups at right angles to a roadway. Secondly, a simple well-made carriage drive, from 12 to 16 ft. wide, for a much larger group of houses where the traffic using the road is little more than required for serving these particular houses. Such a roadway has been proved to be adequate at the Hampstead Garden suburb, where, under their private Act, the Trust is permitted to make such carriage drives provided that through traffic is not arranged, that the length does not exceed 500 ft. and the houses are placed 50 ft. apart. For a third type of road he suggested one more in the nature of a country highway, having a central roadway of 16 or 18 ft., with grass margins and gravel footpaths on each side, the design and treatment to be varied in accordance with local circumstances.

A resolution was passed approving the formation of a special Town Planning and Advisory Committee for the purpose of carefully watching and interpreting the provisions of the Housing and Town Planning Bill after it was passed by Parliament. In the evening the members were conveyed round Southport in tramcars and were dined at the Scarisbrick Hotel by the Corporation of Southport.

On Friday, Aug. 6, the delegates went by special train to visit the Woodlands Colliery village of the Broadsworth Main Colliery Co., near Doncaster, and the Estate of the Joseph Rowntree Village Trust, at New Earswick, near York.

The Relation of Railway Fire-Protection Methods and Oil-Burning Locomotives to Forest Fires.

The destruction of timber by fire in the Adirondack forest reserve, New York State, has been a very serious matter for a number of years, and many complaints have been entered against the railways which traverse the reserve. The number of fires and the enormous fire loss during the summer of 1908 led to an investigation as to the responsibility of the railways for these fires, and this has resulted in definite and practical steps to prevent the large percentage of fires which are started by the locomotives of these railways. This was probably the most thorough investigation of the kind that has ever been made, and it is of interest for this reason as well as for its relation to the general subject of forest protection and conservation. The Adirondack reserve has an area of about 2,400 sq. miles.

At the end of September, 1908, the Forest, Fish and Game Commissioner of the State requested the New York State Public Service Commission to issue an order prohibiting the use of coal as fuel on locomotives running through the preserve (in the summer season). He stated that in a period of 40 days more than 400 fires had been started upon or immediately adjacent to the railway right-of-way. Thousands of incipient fires are extinguished by the men of the forest fire patrol, who have three-mile sections along the railways and follow every train. The state also has inspectors who examine the equipment, and the commissioner acknowledged in his complaint that the railways were diligent in applying the most approved apparatus for the prevention of fires. His conclusion, however, was to this effect:

> All these precautions and all this diligence has gone for practically nothing, and will continue to go for nothing until some strict regulations are made which will absolutely prevent the burning of coal for fuel during the seasons of the year when there is danger of fire.

The matter was taken up by the Public Service Commission (as provided for by law) which held hearings, and obtained information also by correspondence. A summary of the proceedings, with the conditions which led to them and with the official conclusion of the Commission, has been published, and from this we take the information presented below.

The railways in the reserve are bordered largely by land covered with the refuse from lumbering operations and with the partially burned material or "fire-slash" which is left after a fire. This, with weeds and brush, makes a matted mass in which fires start readily. An admittedly absurd clause of the state law relative to forest lands provides that they must be kept in wild condition and that no timber shall be sold, removed or destroyed. This was based on the assumption that the only way to preserve the forests was to absolutely leave them alone, although proper conservation of course provides for the perpetual use and growth of timber. Under this provision, however, it has been held that no clearing of dead timber, fallen trees, etc., is lawful, and cannot be authorized even by the state, although much of the timber is valuable and would be an important source of revenue.

The railway right-of-way, also, is left in a very poor condition, and the fires due to the railways are started as a rule in this 100-ft. strip. The law requires the railways to remove all brush and other inflammable matter from the right-of-way at least twice a year, but it also forbids the "clearing of land" by burning during April and May and from Sept. 16 to Nov. 10, and this prohibition has been held to apply to the clearing of the right-of-way. This method of clearing is stated to be the most efficient and probably the most satisfactory, and the railways have proposed to ask for a modification of the law which will permit them to use this method during any month, under proper supervision.

Defective grates and ashpans on the locomotives appear to be a prolific source of trouble, but sparks are the most important cause of fires, and these start fires usually within the 100-ft. right-of-way. On behalf of the railways it is claimed that many of the fires along their lines are started by settlers and by tramps, and that the railways are responsible for only about 15% of all fires. On the other hand, it has been claimed that from 75 to 90% of the fires in the reserve may be attributed to the railways. The commission considered both these estimates to be without foundation, but concluded (from the statistics available) that the railways are responsible for not more than 40% of the damage. It was not necessary to establish any exact percentage, as it was conceded on all sides that in any event the conditions were so serious as to demand a positive remedy.

Three remedies have been suggested, the first by the railways and the third (which has been adopted by the commission) by the Forest Commissioner: (1) Improvements in the method of operating coal-burning locomotives, clearing right-of-way,* patrolling (aided by a telephone system), and the use of fire-extinguishing trains. (2) Electric operation of the railways. (3) Burning oil instead of coal on the locomotives during the period from April 1 to Nov. 1.

The first method evidently fails to meet the requirements. The commission points out that it provides simply improvements in detail, and that the practical operation of the method has proved unsatisfactory in the years when severe fires occurred. In addition to this, the conditions are such as to invite carelessness, while measures of precaution and rules for safety are likely to be forgotten or relaxed (both by the railway and the state authorities) during the years of practical immunity which follow each year of severe fire losses. Furthermore, the railways have failed to use all precautions in their power to prevent fires, when the dangerous conditions have been called to their attention; and, in the same way, the state authorities have failed to take action until too late to accomplish any immediate effect.

Electric operation of the railways was shown to be out of the question in view of the great cost and the relatively small traffic. The conditions are unfavorable also, as the traffic consists mainly of a limited number of heavy trains. An estimate made by Mr. E. B. Katte, Chief Engineer of Electric Traction, for the 30[illegible] miles of the railways belonging to the New York Central Lines, showed a first cost of $9,163,000 and an annual cost of operation of $1,155,000 in excess of that under the present system. This estimate was submitted to and approved by the General Electric and Westinghouse companies.

The third method, that of using oil fuel, received special attention. It was objected to by the railways on the ground of additional expense for operation. The amount of oil equivalent to a ton of bituminous coal in heating value was stated variously at 133 gals. by Mr. S. M. Vauclain (Baldwin Locomotive Works), 154½ by Mr. Geo. R. Henderson, 168 by the Southern Pacific Ry., and 188 gals. by the New York Central Ry. As the figure of the Southern Pacific Ry. was based on very extensive practical experience (with some 1,100 locomotives) the commission accepted this figure, but stated that there are many indications that even a lower figure would be fair. The cost of repairs to fireboxes was not included, as the Southern Pacific Ry. finds this 25% less than with coal fuel, but the New York Central Ry. (with no experience) estimated $175 additional per year per engine. As a result of the investigation it was estimated that the annual cost due to the use of oil fuel at 2.4 cts. per gal. (on both day and night trains for seven months), would be not more than $55,000 in excess of the cost of the less effectual methods proposed by the railways. This is for 48 locomotives, and would be reduced of course by the use of coal-burning engines at night. As to the efficiency of this method of reducing fire losses, it was shown that the only railway in the Adirondack region which has been free from fire complaints is the Raquette Lake Ry. (19 miles) which burns oil in summer and coal in winter. The only fire set in the forest through which this line runs was caused by a coal-burning engine used to haul a special train (and used in violation of a state law requiring the railway to use oil-burning locomotives).

Some of the railways concerned claimed that there is danger from sparks even when oil fuel is used, but this has been shown to be almost negligible. This has been proved by experience with hundreds of oil-burning-engines in regular service. A lumber company for three years used an oil-burning engine on a right-of-way which was only just wide enough for operation and was bordered by refuse from lumbering operations, yet there were no fires along its line.

Information was obtained from locomotive builders and others as to possible improvements in coal-burning locomotives to prevent the throwing of sparks and dropping of cinders, and this suggested improvements in different directions. It was qualified, however, by statements that coal-burning engines designed for the greatest safety against setting fires (consistent with proper operation) would not offer as complete protection as oil-burning locomotives. On the Southern Pacific Ry., coal-burning engines can be converted for the use of oil fuel at a cost of about $530, and it is estimated that reconverting for coal would cost about $25.

The commission arrived at the conclusion that the only method of preventing the recurrence of railway fires in the Adirondack forest preserve was to prescribe the use of oil fuel. In April, 1909, it issued an order, therefore, providing substantially as follows:

(1) Complete installation of oil burning upon all locomotives within the reserve, to take effect April 15, 1910.

(2) The use of oil fuel between 8 a. m. and 8 p. m. from April 15 to Nov. 1, each year (as already prescribed by law for the Raquette Lake Ry.). This annual period may be shortened on application to the commission, in years of minimum fire risk.

(3) At least two locomotives on both the Mohawk & Malone Ry. and the Delaware & Hudson Ry. to be fitted with oil-burning apparatus and kept in service from July 15 to Nov. 1, 1909.

*It was shown that great additional safety could be secured by clearing brush and waste from an additional strip 50 ft. wide on each side of the right-of-way. This, however, is impracticable under present conditions. The constitutional provision (noted above) prevents it, and even without this there would be the necessity for legislation of some kind to compel owners to clear this strip or allow the railways to clear it.

This is to familiarize the employees with the operation.

(4) The use of properly-equipped coal-burning locomotives (inspected and certified by the commission) is permissible between 8 p. m. and 8 a. m. during the annual period specified.

(5) The coal-burning locomotives to be used during 1909 must be inspected and approved by the commission.

A CLOUDBURST at the head of a dry gulch on the outskirts of Denver, Colo., Aug. 7, caused a flood in the western part of that city. Several houses and bridges were wrecked.

FIRE IN A MINE at Real del Monte, Hidalgo, Mex., Aug. 14, caused the death of three miners. Twenty other men were for some time imprisoned in the mine, but eventually escaped through a tunnel beyond the fire zone. The fire was reported extinguished Aug. 15.

A FIRE AT MONTICELLO, N. Y., Aug. 10, consumed more than 40 buildings in the business section. The local fire department was reinforced by firemen and volunteers from Port Jervis, N. Y., but the hydrant pressure was so low that little could be done to check the spread of the flames.

SIX SPANS OF A TRESTLE COLLAPSED during construction Aug. 16 on the Grand Trunk Pacific Ry., near McGivney's siding, New Brunswick. One workman was killed and five other were injured. The trestle, which spanned Mullin's Brook, was 50 ft. high and 1,400 ft. long.

THE STEAMSHIP "LUCANIA," of the Cunard Line, was purposely sunk in the Huskisson dock at Liverpool, Eng., Aug. 15, to extinguish a fire which had destroyed practically everything combustible in the forward part of the ship. The fire is reported to have started in the saloon kitchen.

A FLOOD IN MEXICO, which was terminated Aug. 11 when the Santa Catarina River returned to its banks, swept away more than 600 houses in San Luisito, a suburb of Monterey, Nuevo Leon. Fourteen persons were drowned. All train service into Monterey was suspended for two days on account of washouts.

A POWDER-MILL EXPLOSION in the Aetna Powder Co.'s mills at Aetna, Ind., Aug. 13, killed two workmen. The explosion occurred in one of the gelatine-mixing houses and involved 500 lbs. of dynamite. The mixing house, with its machinery, was completely wrecked. This is said to be the first fatal explosion at this plant in the past six years.

THE U. S. TUG "NEZINSCOT" overturned and sank Aug. 11 off Cape Ann, Mass., in 30 fathoms of water. Four of the 13 persons on board were drowned. The accident was caused by a wave which boarded the tug and caused a shifting of her cargo which kept her from righting. She kept afloat for about two minutes with one side well down in the water after being struck by the wave and then rolled over and sank. Seven of the survivors escaped in a small boat that remained afloat when the tug went down, and the remaining two clung to a wooden grating and were picked up six hours later.

A HEAD-ON COLLISION of two passenger trains on the Denver & Rio Grande R. R., Aug. 14, at Husted, Colo., 13 miles north of Colorado Springs, caused the death of eight persons and the injury of 50 others. Trains No. 8, northbound, and No. 1, southbound, met at full speed on a curve which prevented the engineers from seeing each other's trains in time to avert the collision. No. 8, drawn by two locomotives, telescoped the baggage car and smoker of No. 1, and all three engines were ditched. The railway officials are reported to have placed the blame upon the crew of No. 8 which was ordered to meet No. 1 at Husted. It is reported that the crew mistook a switch engine and string of cars for No. 1 and believed the track to be clear.

THREE CASES OF BRIDGE DYNAMITING occurred in the past two weeks, at Joliet, Ill., Cincinnati, Ohio, and Mt. Vernon, N. Y. The first-named concerned a steel mill-building in course of erection, and the dynamite in this case was placed in the firebox of a hoisting-engine, wrecking the outfit without other damage. The other two cases concerned uncompleted railway bridges. The damage done in both cases was trivial, but at Cincinnati some houses and several passersby were endangered. All three cases were obviously acts of malice against the contractors, presumably by workmen or representatives of unions. There are suspicions as to the guilty persons in at least two of these outrages, but up to the present nothing has come of them.

AN EXPLOSION OF NATURAL GAS wrecked a four-story storage building Aug. 16 at Cleveland, Ohio. Ten persons were injured. The explosion occurred in the basement. The roof of the building was blown off and the north and south walls demolished. Seven neighboring buildings were set on fire by the explosion, but the flames were extinguished before much damage had been done. The wrecked building was owned by the Wirick Moving & Storage Co.

AN EARTHQUAKE IN JAPAN, Aug. 14, wrecked about 1,400 buildings. The shock was most severe in the vicinity of Biwa Lake on the Island of Nippon. Isuki Mt., an extinct volcano a few miles northwest of the lake, is reported to have collapsed during the earthquake. Incomplete reports give the number of dead as 30 and of injured, 82. One of the cities affected by the earthshock was Osaka, which was recently visited by an extensive conflagration, as noted in our issue of Aug. 5. Kyoto and Nagoya were also heavily damaged.

AN EXPLOSION ON THE SUBMARINE "DRAGON" of the Russian navy near St. Petersburg in the Neva River, Aug. 14, caused the injury of 14 persons, one of whom died in the hospital. The submarine is driven by benzine motors and the explosion occurred with the engine running while the fuel tanks were being filled. The explosion is ascribed to ignorant carelessness of the Russian laborers who were filling the tanks. The "Dragon" was injured chiefly by the fire which followed the explosion and which destroyed a part of the flooring and other interior woodwork. She is one of four submarines to be built in St. Petersburg under the direction of Mr. Simeon Lake, of Bridgeport, Conn., and has a displacement of 480 tons with 1,200 HP.

AN ALTITUDE OF 38,714 FT is reported to have been reached by Lieut. Mina, of the Italian Army, and Mr. Mario Placenzo, on Aug. 10, with the balloon "Albatross." The balloon was a spherical bag of 2,000 cubic meters capacity, but only 1,200 cubic meters of gas were carried at the start. A supply of oxygen was carried for breathing. A temperature of —24° F. was recorded. The previous record for altitude was 37,000 ft. and was made by Messrs. Coxwell and Glaisher in 1862 in England. Some doubt is cast on the earlier record as one of the aeronauts was unconscious and the other partially incapacitated.

A CHANGE IN THE FREIGHT-CAR SITUATION has been going on for a month past. The car surplus, which prior to that had been decreasing very slowly since midwinter, went down much faster since the early part of July, and on Aug. 12 totaled 207,173 cars, a decrease of about 36,000 in two weeks. Box cars and coal cars shared about equally in this decrease. The American Railway Association looks forward to the possibility of a car shortage in another month or two. A similar sentiment speaks from the extensive orders for new cars which were placed during the last few months.

TWO FERRY BRIDGES ARE PLANNED in Europe. The city of Bordeaux, France, has granted a franchise for a ferry bridge across the Garonne at the Place Laine, according to a report from U. S. Consul Moe. The span projected appears to be of considerable length, as it is stated that the river is 525 yards wide. A ferry bridge is also projected at Koblenz, Germany, across the Rhine, spanning the 300-meter width of the stream by a steel arch. This bridge is planned to be double-track, i. e., carrying two ferries moving in opposite directions simultaneously. There is to be a footwalk on the track deck, with elevators for pedestrians in the shore towers. The clearance, however, is unusually low, only about 40 ft. above extreme high water, according to the "Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins."

A HIGHWAY CENSUS is to be taken by the Massachusetts Highway Commission for two periods of one week in August and one in October of the present year. That in August, from the 22d to the 29th, will represent the season of heavy tourist travel, while that in October should show normal conditions of traffic. About 200 stations on state roads have been selected, at each of which an observer will be stationed from 7 a. m. to 9 p. m. each day of the week, in addition to eleven other stations near the large cities where travel warrants a 24-hour observation period. The "Boston Evening Transcript" describes the method of taking the census as follows:

For the purposes of the census traffic will be divided into six divisions, and the daily observation periods will be divided into two-hour sections. The observers will be provided with cards properly numbered and dated for each day and each station. These cards will show the town or city in which the station is situated, the station number, its location and the date. Below is a sort of score card upon which the vehicles to be observed each have a separate space. The subdivisions are, single horse with light vehicle (buggy, carryall, democrat wagon or other pleasure carriage), single horse with heavy vehicle (farm or milk wagon, etc.), two or more horses with light vehicle, two or more horses with heavy vehicle, automobile runabout, automobile touring car.

For each class of vehicles are squares in which for each consecutive two hours are to be noted the vehicles passing in both directions. If a vehicle passes twice it is to be counted twice. This arrangement will provide totals showing the number of vehicles in each class counted each day, and also the total number of vehicles passing in any of the two-hour periods. The cards also will show the number of vehicles of any class counted at any period of the day. On the cards is provided also a place for noting the weather conditions during each two-hour period. The observer is to sign the card at the end of each day's observation and mail it to the division headquarters in a stamped envelope provided for the purpose. After the census is completed the figures on the cards will be tabulated.

The Highway Commission does not plan to have motor cycles, bicycles, pedestrians or cattle included in the census, as it does not consider that by doing so it would obtain any information of use in its present needs, and to include them would complicate the work. The cost of the census will be about $5,000.

A 5,000-KW. EXHAUST-STEAM TURBINE has been placed in operation in the power-house of The Interborough Rapid Transit Co., at Fifty-ninth St. and Eleventh Ave., New York City. This station, previous to this addition, contained nine combined horizontal-vertical, 7,500-HP. engines and three horizontal, 1,250-KW., turbine units. This exhaust-steam turbine is a vertical type and is placed between the first and second engines, taking steam from only one of them, however. Formerly jet condensers were used with the engine, but now the exhaust steam passes through an oil separator and goes to this low-pressure turbine at 12 to 17 lbs. back pressure. It is expected that the condensed steam, after being drawn from the surface condenser in the base of the turbine, will be pure enough for boiler-feed water. The low-pressure turbine drives a 5,000-KW., three-phase, 1,000-volt, 25-cycle induction generator, the leads of which are connected to the generator of the engine without switching apparatus. The turbine has no governor. It is expected that, with these turbines, the capacity of the station can be doubled at an expense of one-third the original cost of the plant.

A SURFACE CONDENSER at the Williamsburg power station of the Transit Development Co., of Brooklyn, New York City, condensing from 164,586 to 220,200 lbs. of steam per hour from a double-flow turbine showed a heat transfer of from 800 to 900 B. T. U. per sq. ft. per hr., per degree difference of temperature between cooling water inside the tubes and the steam; in contrast with the value of 200 to 300 B. T. U. commonly assumed in such apparatus. This condenser was designed and built by the Wheeler Condenser & Engineering Co., of Cartaret, N. J. The novel feature consists in horizontal baffles interposed between the several banks of tubes. These "rain plates" catch the water from the tubes above them and carry it to the outside against the shell, down which it flows to the hot well without coming in contact with other tubes. To permit the passage of the steam past these "rain plates" there are openings, around the edge of which the plate is turned up to form a vertical lip, preventing an overflow of water. These openings are so staggered that the steam will reach all parts of the tubes, insuring complete utilization of all the surface. By preventing, in this way, the steam condensed on the upper tubes from pouring down over the lower tubes, the condensing effect of the lower tubes is increased, apparently raising the specific heat conduction of all the tubes.

THE HEIGHT OF STEPS ON STREET CARS has been a subject of no little discussion and investigation in Toronto in the past year or two. A number of physicians there protested against the use of a 17-in. step as injurious if not dangerous to the passengers. In the fall of 1908, the Ontario Railway and Municipal Board was petitioned to order that the height of all first steps should be fixed at 9 to 12 ins. and of all others at 7 to 9 ins. At a hearing, the Toronto Railway Co. maintained that 33-in. wheels were necessary to give clearance for the motors and that to reduce the first step from the 15 or 16-in. now used would demand an additional step projecting so far into the street that it would constitute a menace to vehicles and pedestrians. At the request of the Board the railway company equipped a double-truck open car with an additional step at 12 ins. from the ground. This was found to be dangerous in the streets and to require the reconstruction of car houses and repair shops. Another car was equipped so that the floor was brought to 38 ins. above the rails, a drop of something like 2 ins. This car was not found satisfactory on account of the lack of safe clearance for brake rods and compressed-air pipes. As a result of the hearing and investigation the board passed the following requirements for new cars. The claims of the company seem to be generally upheld.

On closed single-truck cars the height of the first step above the ground shall be not less than 12 ins., nor more than 15 ins.

On closed double-truck cars the height of the first step above the ground shall be not less than 14 ins., nor more than 16 ins.

On open single-truck cars the height of the first step

above the ground shall be not less than 12 ins., nor more than 15 ins. and the distance between the first and second steps and the second step and the floor of the car shall measure 12 ins. and 9 ins., respectively.

On open double-truck cars the height of the first step above the ground shall be not less than 14 ins., nor more than 16 ins., and the distance between the first and second steps and the second step and the floor of the car shall measure 12 ins. and 14 ins., respectively.

ROLLED STEEL AND CAST-IRON TIES continue to be used as regular rail material in India. The notes of important work in the report of the Railway Board for 1908 include the following: (1) the relaying of 40 miles of 69-lb. rails on wooden ties with new 90-lb. rails on cast-iron "pot" ties; (2) the relaying of 79.65 miles of 75-lb. double-head rails on mixed cast-iron "plate" ties and wooden ties with new 85-lb. bull-head rails on cast-iron (or steel) "plate" ties of the Denham-Oilperts type; (3) the renewal of 7.71 miles and 32.51 miles with new cast-iron "pot" ties; (4) the relaying of 75.25 miles with 80-lb. bull-head rails and 47 miles with 75-lb. double-head rails on cast-iron "pot" ties (12 to the 30-ft. rail length); (5) the relaying of 72 miles with 60-lb. and 41¼-lb. rails on steel ties.

ELECTRIC TRACTION ON ADIRONDACK RAILWAYS, as a preventive of forest fires, has recently been investigated by the New York Public Service Commission of the Second District. The installation of electric equipment was rejected by the Commission on account of prohibitive cost. The opinion was written by Commissioner Sague and is based on a report made by Mr. E. B. Katte, M. Am. Inst. E. E., Chief Engineer of Electric Traction of the New York Central Lines, on the equipment of the Mohawk & Malone, Carthage & Adirondack and the New York & Ottawa railways. The following figures are arranged from Mr. Katte's estimates. On account of the long distances, heavy trains and long intervals between trains, it was judged necessary to estimate for a 11,000-volt alternating-current equipment similar to that employed by the New York, New Haven & Hartford R. R. There would be a steam-turbine generating station at Tupper Lake, feeding 16 substations by 60,000-volt lines. The conditions were held to be entirely unfavorable for economic operation.

General conditions:	
Miles of main track	300
Miles side track	74
Passenger trains per day	67.7
Freight trains per day	27.6
Average weight passenger trains*	166 108 75
Average weight freight trains*	589 438 400
Locomotives replaced	42
KW. capacity power station	15,000
Number electric locomotives	38
Cost of equipment:	
Power station	$1,429,100
Transmission and trolley lines	4,228,000
Substations	840,000
Locomotives	1,900,000
Engineering and construction	1,252,900
Total cost	$9,650,000
Credit for steam locomotives	497,000
Net cost	$9,163,000
Operating cost:	
Electric power	$203,100
Repairs to locomotives	30,910
Repairs to lines	141,200
Fixed charges (11%)	1,062,270
Total charges	1,437,480
Credit supplies for steam locomotives	170,690
Credit repairs to steam locomotives	110,320
Net charges	$1,156,470

*Averages given for each of the three New York Central lines and in the order previously given.

In these estimates coal was assumed to cost $4.10 per ton; current, 0.0065 ct. per KW.-hr.; repairs to electric locomotives, 3 cts. per mile. Repairs to steam locomotives were found to average on these lines 7.97 cts. per mile, while the average cost per mile for fuel, etc., was 12.02 cts.

A TOTAL OF 15,072,220 MILES OF WIRE were in use in 1907 in this country by the various telephone and telegraph systems, according to advance reports of Bulletin 102 of the U. S. Census Bureau. Of this length of wire, 12,999,369 miles was controlled by telephone companies. Of this again, 5,092,223 miles were in open aerial lines; 2,917,114 were in aerial cables; 4,969,302 miles were underground and 20,730 were in submarine lines.

Of the 2,072,851 miles of wire controlled by the telegraph companies, 1,958,336 miles were in open overhead lines; 41,886 miles were in overhead cables; 65,247 miles were underground, and 7,382 miles were in submarine cables. There were, in 1907, six commercial wireless telegraph systems, operating 122 land stations at the most important ports of the Atlantic and Pacific coasts and of the Great Lakes. The U. S. Bureau of Naval Equipment had installed 44 shore stations at the close of the year.

LEFT-HAND RUNNING OF TRAINS is being abandoned by the Lake Shore & Michigan Southern Ry., and the change has been made already on the division between Chicago and Elkhart, Ind. This has involved extensive changes in tracks, crossovers, yard entrances, coaling stations, etc., and also changes at industrial spurs so as to avoid facing switches. Many of the signals were moved a few days before the change, and duplicate signals and connections were installed at interlocking plants, to save the time and confusion of making changes. On the day of the change, gangs of men made the necessary connections at the interlocking plants and for the block signals. The Chicago & Northwestern Ry. is the only other important road using the left-hand system, and it is reported that this railway is contemplating a change to conform with the otherwise universal right-hand system.

THE NEWARK, N. J., PUBLIC DOCK and ship canal project, described in our issue of July 23, 1908, p. 98, has been made the subject of two reports additional to those noted in our previous description. The first of the new reports is dated March 30, 1909, and is by Messrs. George S. Greene, Jr., and Henry S. Adams, who were called in by the Mayor to criticize the scheme proposed by the Advisory Dock and Meadow Reclamation Co. In general the two consulting engineers agree with that scheme and believe that it is entirely feasible and desirable. In some instances, particularly in the exact location of the ship canal, the best place to start the work of reclamation and unit prices, Mr. Adams differs from the commission and on his own part submits alternative plans. The second new report is dated July 22, 1909, is from the Commission, and is a defense of the criticisms of the advisory engineers. Both reports are in printed form and are available from the Mayor of Newark.

Personals.

Mr. William S. Corn has been appointed City Engineer of Billings, Mont.

Mr. Matthew C. Brush has resigned his position as Vice-President and General Manager of the Boston Suburban Electric Cos., of Newton, Mass.

Mr. F. G. Faukner has been reappointed to his former position as Assistant Superintendent of the St. Louis & San Francisco R. R. at Newburg, Mo.

Mr. S. M. Felton, formerly President of the Chicago & Alton R. R. and, more recently, President of the Mexican Central Ry., has been chosen to be President of the reorganized Chicago Great Western Ry.

Mr. Herbert J. Wild, Assistant Engineer in charge of the alinement of the Pennsylvania R. R. tunnels under the North River, has been appointed Resident Engineer of the Holter Dam on the Missouri River at Holter, Mont.

Mr. E. B. Black, formerly with the Riggs & Sherman Co., Toledo, Ohio, superintending the installation of sewer systems and sewage-disposal plants, has become a member of the J. S. Worley Co., engineers, Kansas City, Mo.

Mr. Paul H. Smith, formerly District Engineer of the Westinghouse Electric & Mfg. Co. in charge of the erecting department in St. Louis, Mo., has been appointed Superintendent of the Pittsburg & Butler Street Ry., Pittsburg, Pa.

Mr. W. J. Crocken, City Engineer of East St. Louis, Ill.; Mr. Wilford A. Thompson, Assoc. M. Am. Soc. C. E., and Mr. E. M. Crocken have formed a partnership for the practice of general civil engineering under the name of East St. Louis Engineering Co., with offices in the Arcade Bldg., East St. Louis, Ill.

Mr. J. J. Brown, M. Am. Soc. M. E., has become Vice-President and General Manager of the Wheeler Condenser & Engineering Co. Mr. Brown entered the condenser field about 15 years ago as Southwestern Manager of the Henry R. Worthington Co., of which he later became General Sales Manager, and was afterward General Western Sales Manager of the International Steam Pump Co.

Mr. C. H. Gerber has resigned his position as Assistant Engineer in the office of the chief engineer of the Union Pacific R. R. and has been appointed First Assistant Engineer on Physical Valuation for the State Railway Commission of Nebraska. Mr. Gerber has served with the Union Pacific R. R. nine years, during a portion of which time he was connected with the construction department as Assistant to the Resident Engineer, and was later Resident Engineer in charge of work, including the Lane cutoff, second track between Lane and Kearney, Neb., the extension of several branches and permanent bridge work.

Obituary.

James V. Wilson, who was for 14 years General Master Mechanic of the Chicago, Milwaukee & St. Paul Ry., died Aug. 9 at Elgin, Ill., aged 73 years. He was born in Glencoe, N. Y., and when a young man entered the service of the C., M. & St. P. Ry. at Madison, Wis. He was promoted to be a locomotive engineer when about 20 years old, and remained in this position until he was made a master mechanic in 1892. He is credited with a record of more than 2,000,000 miles at the throttle of a locomotive without an accident. As General Master Mechanic, his headquarters were at Chicago, Ill. Feeling unequal, at his advanced age, to the task of meeting the many responsibilities of this position, he resigned in 1906 and has since then been employed as an engineer on the run between Elgin and Chicago.

Henry G. Parker, Assistant City Engineer of Los Angeles, Cal., was drowned Aug. 6 in the Los Angeles outfall sewer at Hyperion, near Redondo Beach, Cal. Mr. Parker had been supervising repairs to one of the floodgates of the sewer and, accompanied by the superintendent of the sewer, had descended into a manhole about 1,000 ft. from the point where the sewer enters the ocean. The two men were soon compelled by sewer gas to return to the surface. Mr. Parker sat on the edge of the manhole with his feet hanging inside while resting before returning to the work. After some minutes in this position and while talking of again descending into the manhole, he suddenly pitched forward and fell 20 ft. into the torrent of sewage. His body was discharged into the sea but floated and was recovered. Mr. Parker was born in Minnesota in 1869, went to California when at the age of 7 years and graduated at the University of California in the class of 1890. He was employed for some time as a bridge engineer for the Denver & Rio Grande R. R. and entered the employ of the city of Los Angeles about five years ago. He was at one time in charge of the bridge building department of the city engineer's office and designed a number of large highway bridges.

Engineering Societies.

COMING MEETINGS.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 25-27. Annual convention at Montreal, Can. Secy., John MacVicar, Des Moines, Iowa.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Aug. 31-Sept. 2. Annual meeting at Briarcliff Manor, N. Y. Secy., D. L. Huntington, Spokane, Wash.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual convention at Denver, Colo. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 8-10. Annual convention at New York City. Secy., Willard Kent, 715 Tremont Temple, Boston, Mass.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 14-16. Annual convention at Atlantic City, N. J. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 14-17. Annual meeting on board steamer sailing from Detroit, Mich. Secy., A. P. Ewing, Gas Office Bldg., Detroit, Mich.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 14-17. Annual convention at Washington, D. C. Secy., Walter E. Emery, Peoria & Pekin Union Ry., Peoria, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 14-17. Annual convention at Niagara Falls, N. Y. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-Oct. 12. Annual convention and excursion on special train starting at Chicago, Ill. Secy., R. W. Raymond, 29 W. 39th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at New York City. Secy., P. S. Millar, 25 W. 39th St., New York City.

AMERICAN STREET & INTERURBAN RAILWAY ASSOCIATION.
Oct. 4-8. Annual convention at Denver, Colo. Secy., Bernard V. Swenson, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 12-14. Annual convention at Louisville, Ky. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19. Annual convention at Jacksonville, Fla. Secy., S. F. Patterson, Boston & Maine R. R., Concord, N. H.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 19-22. Annual convention at Richmond, Va. Secy., Chas. O. Probst, Columbus, Ohio.

AMERICAN GAS INSTITUTE.
Oct. 20. Annual meeting at Detroit, Mich. Secy., A. B. Beadle, 29 W. 39th St., New York City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The August meeting is to be held in Atlanta, Ga., Aug. 19. Dr. T. A. Hancock, Surgeon for the Southern Ry., will give a lecture on "First Aid to the Injured." The lecture is to cover both railway and shop accidents.

ILLUMINATING ENGINEERING SOCIETY.—The third annual convention of this society will be held in New York City, Sept. 25, 26 and 27, at the time of the Hudson-Fulton celebration. The sessions will be held in the Engineering Societies' building, 25 West 39th St. A long list of papers has been prepared, largely on research work, it is reported. The premises at 5 West 30th St. have been secured as an exhibition place.